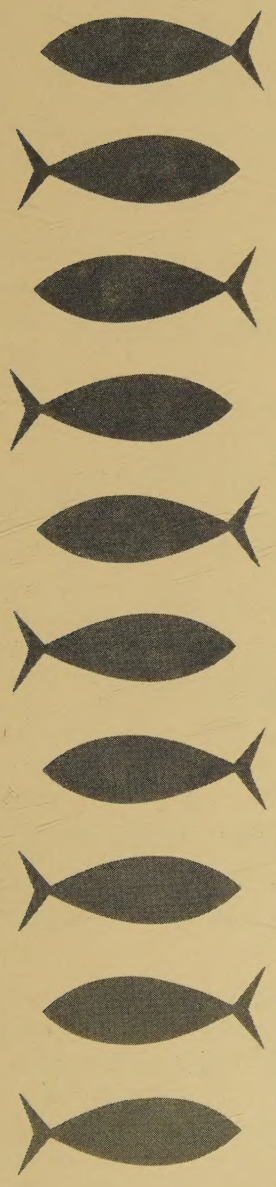
Southwest
FISHERIES SCIENCE CENTER

HONOLULU LA JOLLA MONTEREY TIBURON



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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

1992 AMLR Research Cruise Completed

The NOAA Ship *Surveyor* departed from Punta Arenas, Chile, on February 18, 1992, to begin Leg II of the 1992 Antarctic Marine Living Resources (AMLR) research cruise. The Suryeyor took her departure from South America via the eastern end of the Strait of Magellan. A series of expendable bathythermographs (XBTx) were conducted while in transit across Drake Passage at the request of Chile's Servicio Hidrografico y Oceanografico de la Armada (SHOA) to describe the geostrophic current flow through the Drake Passage. The ship arrived at Seal Island on February 21, and fresh provisions and mail were transferred to the Seal Island field camp, which was activated in early December 1991. Each year a field team spends approximately 4 months on the island conducting reproductive and feeding behavior studies on krill predators (seals and penguins). Monitoring the population of krill predators will help evaluate the importance of krill to the upper trophic levels of the Antarctic ecosystem.

After re-provisioning of the camp was completed, Don Croll of the National Marine Mammal Laboratory (NMML) boarded the ship from the field camp and he and Rennie Holt, cruise leader from the Southwest Fisheries Science Center (SWFSC), completed a census of South Shetland Islands fur seal rookeries that had been initiated earlier in the season by John Bengtson and Peter Boveng (both of NMML). Counts of pups, adult females, and adult males were made at six sites: Livingston Island (Telmo Island, Window Island, Start Point, and Desolation Island); near King George Island (Stigant Point), and on Elephant Island (Cape Lindsey). A preliminary comparison of this census with one completed 5 years ago at the same sites indicates that the number of fur seal pups produced in the South Shetlands has increased significantly.

A small-area acoustic survey (Survey C), a duplicate of one made on Leg I of the cruise, was conducted to the north of Elephant Island from February 25 to 28. Except at three plankton-sampling stations, the acoustic system was operated continuously at a ship's speed of 10 knots. The survey revealed that krill abundance and distribution had changed dramatically from Leg I to Leg II. The high concentration of krill present throughout the survey area during Leg I had almost completely disappeared, leaving a high density only northwest of Seal Island and a few pockets just offshore from Elephant Island to the northeast. In addition, scientists delineated a region of high krill density in the upper northwest corner of the survey area that had not existed during Leg I (Figure 1).

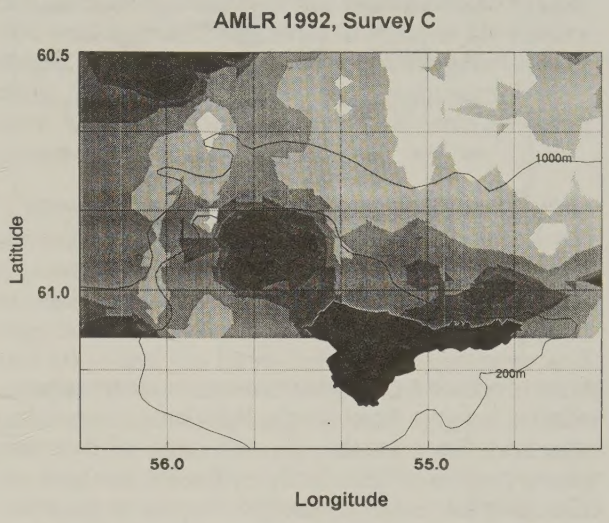

Figure 1. Krill density in small-area acoustic Survey C.

On February 26, designated Commission for Conservation of Antarctic Marine Living Resources (CCAMLR) inspectors Rennie Holt and Ensign Victor Ross, of the NOAA Corps, inspected a Russian krill fishing vessel, the *Poytr Sgibnev*, under the guidelines of the CCAMLR Inspection Program. The Russian ship's captain, Vaycheslav Bulatov, told the inspectors that the ship had been fishing for krill around the South Orkney Islands and had just arrived in the Elephant Island area to search for krill. He showed the inspectors his log book, written in Russian, which indicated that catches had been 100 percent krill. The inspection team was given a very complete tour of the ship, and all required inspection forms were completed by Ensign Ross and Captain Bulatov. Due to the cooperation and assistance of the *Surveyor's* command, as well as the command of the *Poytr Sgibnev*, the inspection went very well.

A large-area survey (Survey D), similar to one made on Leg I (Survey A), was completed around Elephant, Clarence, and Gibbs Islands from February 29 to March 11 (Figure 2). The large-area survey consisted of 72 conductivity-temperature-depth (CTD)/rosette and plankton-sampling stations, separated by acoustic transects. Operations at each

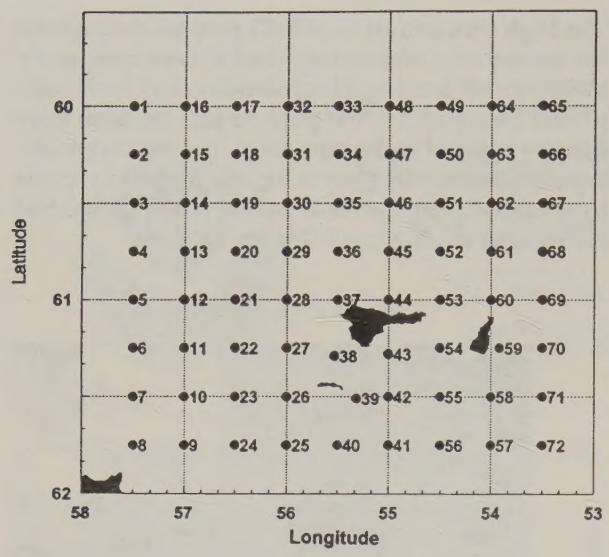

Figure 2. Large-area survey station locations (Surveys A and D).

station included (1) measurement of temperature, salinity, oxygen, light levels, light beam transmission, and fluorescence; (2) collection of discrete water samples at standard depths for analysis of chlorophyll-a content, absorption spectra, particulate organic carbon and nitrogen content, primary production, ATP and DNA content, size fractionation, floristics, and inorganic nutrient content; and (3) deployment of a 6-ft Isaacs-Kidd Midwater Trawl (IKMT) to obtain samples of zooplankton and nekton.

Seal Island field team scientists Donald Croll, Scott Manley, John Jansen, and Hector Douglas (all of NMML) were recovered from the camp on March 11. Other members of this season's team, Peter Boveng and Michael Goebel of NMML, had been retrieved earlier in the season. Prior to leaving, the team prepared the camp for winter.

To collect data on the oceanography and biology associated with the shelf break, four cross-shelf transects, which included acoustic surveying, CTDs and plankton-sampling stations, were completed north of Elephant Island on March 12. A fine-scale acoustic survey, consisting of a 1-mile by 1-mile grid with north-to-south and east-to-west transects spaced approximately 100 meters apart, was conducted west of Elephant Island from March 13 to 14. The abundance and distribution of krill were monitored in this area for a 48-hour period. This study will help scientists gain knowledge about the day-to-night behavior of krill swarms. Volume visualization software will be used to analyze and display the data collected during this survey.

Continuous underway measurements during both legs included the ship's position, true wind speed and direction, air temperature, relative humidity, barometric pressure, light levels at several spectra, sea surface water temperature, salinity, light beam transmission, and fluorescence. In addition, marine mammal and bird observations were made throughout the cruise.

The *Surveyor* departed from the Elephant Island area on March 15 and arrived in Punta Arenas on March 18, 1992. After a short call at port, the ship departed from Punta Arenas on March 21 to begin the northbound transit back to the *Surveyor's* home port of Seattle, Washington. During the 33-day transit, various research projects were conducted, including bacterioplankton research, physical oceanographic and meteorological studies, an investigation of the effects of solar ultraviolet radiation on photosynthetic rates of phytoplankton, and observations of marine mammals and seabirds. The *Surveyor* arrived in Seattle on April 22, bringing to a close the 1992 AMLR research cruise. (J. Rosenberg, [619] 546-5600).

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

California Cooperative Oceanic Fisheries Investigations Ichthyoplankton Atlas

A major ichthyoplankton project nearing completion in the Coastal Fisheries Resources Division is a two-volume atlas that will summarize the areal and temporal distribution and abundance of all larval fish taxa collected on California Cooperative Oceanic Fisheries Investigations (CalCOFI) surveys from 1951 to 1984. This is a cooperative project involving personnel of three research groups within the division: Ecology and Systematics of Fishes, headed by Fishery Biologist H. Geoffrey Moser; Coastal and Pacific Fisheries Resources Investigations, headed by Fishery Biologist Richard L. Charter; and Survey Systems Development and Evaluation, headed by Fishery Biologist Paul E.Smith. The project began with the construction of a computer data base which stores fish larvae data collected from the 1951-1984 CalCOFI surveys. The data base was completed in 1990, and work on the atlas was initiated. The atlas will consist of summary distribution maps and graphs for approximately 245 taxa. Taxa will appear in the order of

their total abundance, with volume I including taxa represented by more than 1000 total occurrences in samples during 1951 to 1984. For each taxon, there will be a map of total abundance for the time series, a series of maps summarizing abundance in each of 22 CalCOFI regions, and a series of graphs summarizing seasonal, interannual, and on/offshore incidence and abundance. In addition to the program leaders, other authors of this atlas are Computer Program Analyst Cynthia A. Meyer; Fishery Biologists David A. Ambrose, Sharon R. Charter, and William Watson; and Biological Technician Elaine Sandknop Acuna. The project is scheduled to be completed in 1992. (G. Moser, [619] 546-7129; R. Charter, [619] 546-7157; P. Smith, [619] 546-7169)

California Cooperative Oceanic Fisheries Investigations Identification Guide

A second project nearing completion in the Coastal Fisheries Resources Division by the Ecology and Systematics of Fishes group is an identification guide to the early life history stages of approximately 400 species of teleost fishes of the California Current Region. The work is based primarily on CalCOFI survey collections and on ichthyoplankton surveys of adjoining regions. The guide will include about 132 families and 328 genera of fishes with chapters arranged phylogenetically. The book will be edited by Fishery Biologist H. Geoffrey Moser and will include chapters by Moser, Fishery Biologists William Watson, David A. Ambrose, and Sharon R. Charter, Biological Technician Elaine Sandknop Acuna, and former staff members of the program, Elizabeth G. Stevens and Barbara Sumida MacCall. Illustrations for many of the life history series were made by MacCall under a contract funded by NOAA's Minerals Management Service. For each taxon, essential meristic and morphometric characters; life history characteristics; a summary of morphological and pigment characters of eggs, larvae, and juveniles; diagnostic characters; and pertinent literature citations will be presented, as well as illustrations of eggs, larval stages, and juveniles. Publication is planned for 1994. (G. Moser, [619] 546-7129)

Population Genetics of Three Continental Slope Groundfishes, Based on Mitochondrial DNA Sequence Data

Carol Stepien, National Research Council (NRC) fellow in the Coastal Fisheries Resources Division, is using molecular genetic techniques, including the polymerase chain reaction (PCR) and DNA sequencing, to analyze and compare population genetic variation in three commercial groundfishes which share a common habitat and distribution: the Dover sole, *Microstomus pacificus* (Pleuronectidae), and the short- and long-spine thornyheads, *Sebastolobus alascanus* and *S. altivelis* (Scorpaenidae). They range along a narrow ribbon of the continental slope, 400 to 1000 m in depth from Alaska through central Baja California, Mexico, which extends across three biogeographic provinces. The species vary significantly in key features of their life histories, including length of the planktonic larval period and degree of dispersal at various life history stages. This presumably affects their genetic variation. DNA sequence data from eight sample sites from Alaska through southern California are being analyzed and compared.

Stepien's objectives are (1) to compare genetic variation and relationships of subpopulations from regions of their geographic ranges; (2) to determine whether "stocks" of these fishes are genetically distinguishable for fisheries management purposes; and (3) to test the larval retention hypothesis and interpret similarities and differences in population genetic structures among the four species in relation to their biogeographic distributions, current patterns, and life-history traits. The primary scientific hypothesis to be tested is that fishes from the same habitat, with different life history and dispersion patterns, exhibit similar patterns of population and subpopulation genetic structure and relationships.

Methodology consists of four basic steps: (1) extraction and purification of whole genomic DNA, (2) amplification of the target region using the PCR and oligonucleotide primers from conserved sequence areas, (3) sequencing of the amplified region using the Sanger di-deoxy method, and (4) reading the DNA sequences from autoradiographs and analyzing the data. The genetics laboratory at the Southwest Fisheries Science Center has the capability for one researcher and technician to analyze approximately 25 fish in one week. The procedure is comparable in cost and time to restriction site analysis and yields data with considerably higher resolution for analyzing population genetic problems.

About 500 bases from the mtDNA control region, including the highly variable D-loop, are being sequenced from samples of the four species. Mitochondrial DNA is maternally inherited and evolves approximately 5 to 10 times more rapidly than most nuclear DNA regions; the latter is believed to be a result of lack of proofreading by mtDNA polymerase. The control region is very attractive for population genetic studies due to its high variability, its lack of transcription, and the consensus that

mutations in this region are selectively neutral. Variations discerned among populations are thus believed to be the result of random mutation and genetic drift, rather than due to natural selection.

Fifteen individuals per subpopulation are being analyzed from Alaska, Oregon, Northern California, Monterey, Morro Bay, Santa Barbara, Cortez Bank, and San Diego. Genetic variation for the three species analyzed to date ranges from 7 to 12 percent, with the shortspine thornyhead being the most variable. These percentages of variation are within the ideal range of 5 to 15 percent variation for detecting genetic relationships. The Dover sole exhibits somewhat less variation among different sites, which is presumably due to its longer larval period (and hence greater dispersal). The longspine thornyhead is less variable than the shortspine, which may be a consequence of its longer pelagic juvenile stage. Table 1 shows a summary of the amount of overall variation in the mtDNA control region for the three species.

Table 1. Summary of amount of overall variation in the mtDNA control region for *Sebastolobus alascanus*, *S. altivelis*, and *Microstomus pacificus*.

Species	Number of Variable Sites	Number of Base Substitutions	Number of Transitions	Number of Transversions
S. alascanus	54/475= 11.4%	56/475= 12%	46/56= 82%	10/56= 18%
S. altivelis	30/475= 6.3%	31/475= 7%	22/31= 71%	9/31= 29%
M. pacificus	46/500= 9.2%	49/500= 10%	33/49= 68%	16/49= 32%

Table 2. Selected examples of frequencies of base substitutions for *Sebastolobus alascanus* from areas sampled.

BASE NO.	BASE	POPULATION					
		Alaska	Oregon	Monterey	Morro Bay	Santa Barbara	San Diego
180	T:	1.000	0.727	0.083	1.000	1.000	1.000
	C:		0.273	0.083			
200	G:	0.400	0.250	0.583	0.556	0.625	0.636
	A:	0.600	0.750	0.417	0.444	0.375	0.364
218	T:	1.000	1.000	0.917	0.888	0.775	1.000
	C:			0.083	0.111	0.125	
222	C:	1.000	0.917	1.000	0.888	0.625	0.910
	A:		0.083		0.111	0.125	0.090
	T:					0.250	
224	T:	1.000	1.000	1.000	1.000	0.750	0.910
	C:					0.250	0.090
245	A:	0.900	0.917	0.917	1.000	1.000	1.000
	G:	0.100	0.083	0.083			
254	T:	0.400	0.417	0.583	0.778	0.625	0.818
	C:	0.600	0.583	0.417	0.222	0.375	0.182
258	C:	0.900	0.917	0.750	0.778	0.750	0.818
	T:	0.100	0.083	0.250	0.222	0.250	0.182
310	G:	0.900	1.000	1.000	1.000	0.750	0.909
	A:					0.250	0.091
	T:	0.100					
311	A:	1.000	0.750	0.667	0.667	1.000	0.909
	G:		0.250	0.333	0.333		0.091
314	T:	0.900	0.909	0.833	0.778	0.625	0.636
	C:	0.100	0.091	0.167	0.222	0.375	0.363
341	T:	0.800	1.000	0.917	0.889	0.750	0.818
	C:	0.200		0.083	0.111	0.250	0.182

Sequence data demonstrate a significant north-south clinal variation pattern for all three species. Table 2 contains some of the base substitutions which show relationships among sample sites for the shortspine thornyhead (data shown are for only six of the eight sites since data collection and analysis are still being completed). A Nei's (1972) genetic distance analysis, which computes genetic relationships among sample sites based upon summaries of frequency variations, is shown in Table 3. These

Table 3. Nei's (1972) genetic distances (D) among population areas sampled for shortspine thornyhead, *S. alascanus*, calculated from base substitution frequencies. Nei's distances are postulated to be related to evolutionary time (a value of 1.0 = about 1.9×10^6 years).

	Alaska	Oregon	Monterey	Morro Bay	Santa Barbara
Alaska	--				
Oregon	0.017	--			
Monterey	0.016	0.012	--		
Morro Bay	0.027	0.018	0.016	--	
Santa Barbara	0.024	0.026	0.020	0.024	--
San Diego	0.022	0.019	0.013	0.016	0.014

distances were used in a cluster analysis in the program FITCH of PHYLIP 3.1 (Felsenstein, 1991), demonstrating that relationships among population areas reflected geographic proximity (Figure 1). For example, Figure 1 shows that Alaska and San Diego are the most genetically separable areas examined. A maximum likelihood analysis of the frequency data (CONTML, PHYLIP 3.1; Felsenstein, 1991) agreed with the close relationship between the San Diego and Santa Barbara sites as well as between Morro Bay and the former.

Results to date show a significant degree of genetic variation along the extensive range of the three species. The amount of variation discerned by mitochondrial DNA sequencing is much greater than that detectable by either allozyme or restriction enzyme fragment data approaches. The present study indicates that mitochondrial DNA sequencing offers considerable resolution for examining patterns of subpopulation and fishery stock relationships. (C. Stepien, [619] 546-7105)

Dover Sole Larvae Aged Using Scanning Electron Microscope

The growth rate and duration of larvae in plankton are important factors determining recruitment

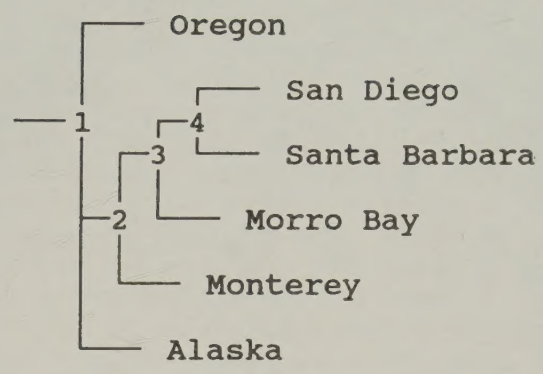

Figure 1. Genetic distance tree calculated from FITCH program of PHYLIP vers. 3.1 (Felsenstein, 1991) and Nei's (1972) genetic distances (see Table 2). Sum of squares for this tree = 0.138. This tree is unrooted and thus does not show the relationship among the Alaska and Oregon populations.

variability. Dover sole hatch at about 8 mm and reach a size of 45 to 55 mm before settling to the bottom. Based on size-frequency modes in seasonal samples, the duration of the larval phase of Dover sole larvae has been estimated to be up to a year in the plankton (Pearcy et al. 1977). Recently, Doug Markle of Oregon State University has suggested that the larvae may spend two years in the plankton before settlement.

Fishery Biologists John Butler and Geoff Moser and Biological Technician Kathy Dahlin have been reading daily increments in otoliths to determine growth rates and duration of the larval phase of Dover sole. Fishery Biologists Dave Ambrose and Sharon Charter and Biological Technician Elaine Acuna collected larvae in multiple opening/closing net and environmental sensing system (MOCNESS) samples and preserved them in ethanol for otolith analysis. Butler attempted to read daily increments using light microscopy but concluded that the otoliths could not be analyzed by conventional means because the increments were smaller than the resolution of light microscopy. Thus, scanning electron microscopy (SEM) was the only method available for reading the otoliths, and Dahlin received training on the use of the scanning electron microscope at Scripps Institution of Oceanography.

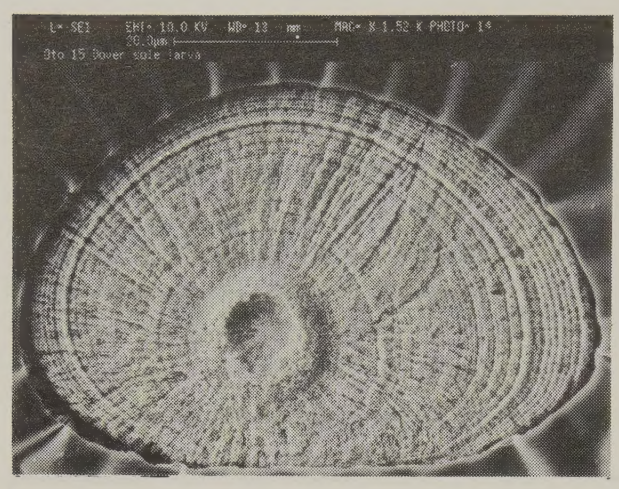

Figure 2. Scanning electron microscopy (SEM) micrograph of the sagitta of a 17 mm Dover sole larvae. Distance from core to outer edge is 38 μ. Width of smallest increments is about 0.5 μ. Distance from center to first increment is about 10 μ. About 46 increments are visible.

Otoliths were embedded in casting resin and after being polished to the core, they were etched with 5 percent EDTA buffered to pH 7.5. Great skill is required to polish the otoliths to the exact plane of the nucleus because there is only a tolerance of a few microns. Due to Dahlin's diligence, however, she was able to successfully image daily increments on the first attempt.

The SEM micrographs reveal fine increments near the core of the otolith which are about 0.5 microns in width, the theoretical limit of light microscopy (Figure 2). Two larvae have been aged, the smallest is 17 mm live length and has 46 increments and the larger is 20 mm in length and has 68 increments. Dover sole hatch at about 8 mm, hence the growth rate is about 0.2 mm per day. (J. Butler, [619] 546-7149)

Recent Trends in Sardine Biomass

Tom Barnes, of Living Marine Resources Inc. in San Diego, California; Larry Jacobson, head of the Southwest Fisheries Science Center 's (SWFSC) Commercial and Recreational Fisheries Research for Management task; Alec MacCall, director of the SWFSC's Tiburon Laboratory; and Patty Wolf, of the California Department of Fish & Game, Long Beach, California, have completed an analysis of recent trends in sardine biomass that will be published in the next issue of CalCOFI Reports. Sardine biomass (fish age 2 and older) during 1990 was estimated to be about 115,000 t with a 95 percent confidence interval of 62,000 to 214,000 t. Biomass estimates from the new analyses for 1966 to 1990 extend the time series of abundance estimates for 1932 to 1965 from virtual population analyses (Figure 3).

Recent estimates of sardine biomass, like the historical estimates, indicate that water temperatures and fishing both affect abundance of sardine. The historical record (pre-1965) indicates that sardine biomass decreased in the late 1930s and early 1940s when annual exploitation increased beyond 20 percent annually and sea surface temperatures declined to, or below, the historical average of 16.9 °C.

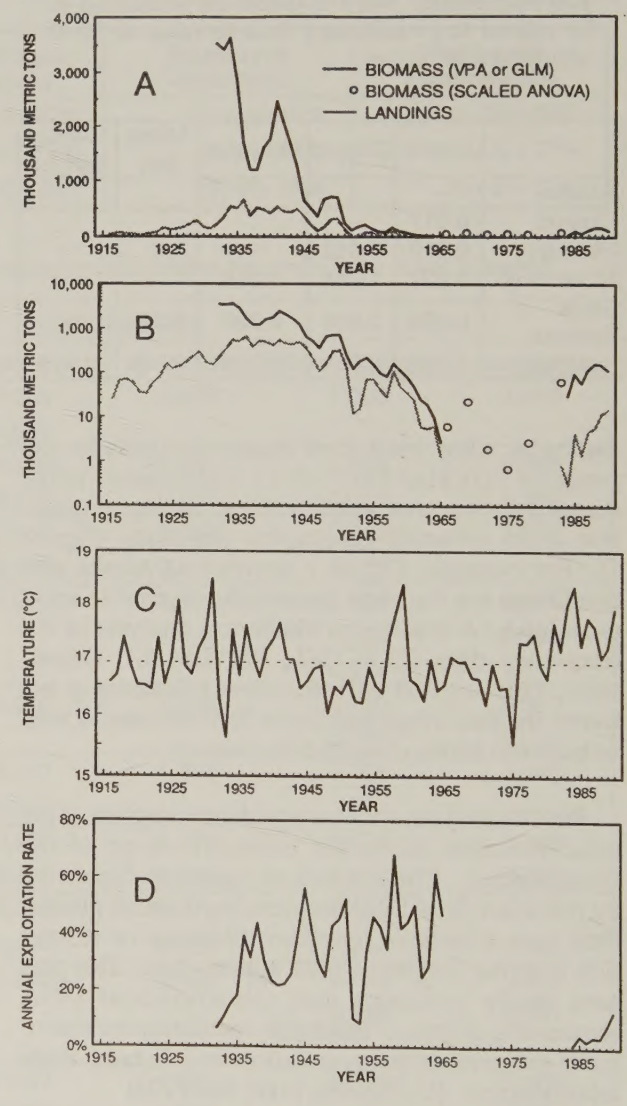

Figure 3. Biomass estimates and landings data for Pacific sardine (panels A and B), mean annual sea surface temperature data from Scripps Pier (Panel C), and annual exploitation rates for sardine (Panel D). VPA=virtual population analysis; GLM=generalized linear model; ANOVA=analysis of variance.

Exploitation rates during 1941 to 1965, when sardine biomass declined consistently, were generally higher than 30 percent, and in 1958 were as high as 68 percent. Temperatures during the same period were generally well below the historical average except during the El Niño of 1957 to 1959.

Estimates for recent years (1965 and after) indicate that sardine biomass remained low during 1965 to 1974 when recorded landings were nil and temperatures were generally below average. Biomass began to increase in about the late 1970s when water temperatures rose above the historical average and exploitation rates remained near zero. Sardine biomass continued to increase during the late 1970s to 1990 as warm water conditions continued and exploitation rates remained less than 10 percent per year. (L. Jacobson, [619] 546-7117)

MARINE MAMMAL DIVISION

La Jolla, California

FISHERY-DEPENDENT ANALYSIS PROGRAM

Strategic Plan Prepared to Develop and Evaluate "Dolphin-safe" Methods

The 1988 Amendments to the Marine Mammal Protection Act (MMPA) stipulated identification of appropriate research into promising new methods of locating and catching yellowfin tuna without endangering dolphins. The amendments require that a strategic research plan, after a period of public review and comment, is to be submitted by the Secretary of Commerce to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Merchant Marine and Fisheries of the House of Representatives.

To develop the plan, Southwest Fisheries Science Center (SWFSC) scientists Douglas DeMaster, chief of the Marine Mammal Division, and Elizabeth Edwards, task leader of the Fishery-dependent Analysis Program, and John Young, of the Southwest Region Office, first compiled a preliminary suite of "dolphin-safe" research proposals, based on recommendations from various sources. This preliminary suite of proposals was reviewed by a panel of experts at a special meeting convened at the SWFSC March 5-6, 1992. The comprehensive strategic plan was developed for 1992 and beyond, based on the advice and comments of the expert panel which stressed the necessity for research to improve understanding of the behavioral association between dolphins and yellowfin tuna in the eastern tropical Pacific (ETP) and to develop new methods for locating and catching yellowfin tuna without the incidental taking of dolphins (detailed in SWFSC Administrative Report LJ-92-16). The National Marine Fisheries Service (NMFS) is currently seeking comments on this plan. Public review and comment on the plan are being solicited through a summary announcement placed in the *Federal Register*.

In summary, NMFS is proposing four specific studies in 1992: 1) An investigation of the feasibility of locating tuna not visibly associated with dolphins or other surface cues utilizing an airborne light detecting and ranging device (LIDAR)- $80,000; 2) An evaluation of the potential for using environmental predictors of yellowfin tuna abundance, catchability, and distribution- $135,000 (joint study with the Inter-American Tropical Tuna Commission (IATTC); 3) A simultaneous tracking study of dolphin and tuna- $765,000 (joint study with the IATTC), and 4) A study of food habits of tunas and dolphins- $166,000 (joint study with the IATTC). In addition, NMFS is proposing to solicit additional proposals with an open Request for Proposals. It should be emphasized that most of the proposed research is directed at developing alternative methods of fishing rather than improving existing methods of fishing. (E. Edwards, [619] 546-7099)

DOLPHIN ECOLOGY PROGRAM

Special Meeting of the International Whaling Commission Scientific Committee

During March 2-6, 1992, the Scientific Committee of the International Whaling Commission (IWC) met in Copenhagen, Denmark. Stephen Reilly, leader of Southwest Fisheries Science Center's (SWFSC) Dolphin Ecology Program, participated as part of the U.S. delegation and as vice-chairman of the Committee. It is unusual for the full Scientific Committee to meet between regularly scheduled annual meetings (normally in May or June), but there were many complex, sensitive issues to be addressed regarding the development of the Revised Management Procedures. These procedures have been under development during the morato-

rium on commercial whaling and were originally scheduled to be completed last year.

Not surprisingly, there has been considerable debate on whether it is possible in principle to manage the exploitation of whales in a manner that will not repeat the infamous history of whale fisheries, with its record of systematic depletion of population after population. Five competing procedures were initially under development, each stressing a slightly different balance of minimizing risk of over exploitation while providing stable, maximum yields. Common to all candidate procedures was an adaptive management approach in which quotas are adjusted based on feedback from sighting surveys conducted independently of whaling operations. The Committee also attempted to account for the generally low precision of abundance estimates and our uncertainty about whale population dynamics. During the 1991 annual meeting in Reykjavik, Iceland, the Scientific Committee selected one procedure as the best, based on results of extensive simulation trials. The procedure adopted was developed by Justin Cooke, a British scientist now residing in Germany. The Cooke or "C" procedure was developed for application to a well-defined, discrete stock. While this provided an essential beginning, it was generally acknowledged that well-defined, discrete whale stocks are rare, and it was essential to further develop the "C" procedure to account for the complexities and uncertainties resulting from multiple stocks. This was the focus of the meeting in Copenhagen.

A set of "multi-stock rules" was developed and adopted at the meeting. Following these rules, "small areas" will be defined as areas small enough to contain whales from only one biological stock, or of a size that if whales from different stocks are present, catching operations would not harvest them in proportions different from their proportions in the area. "Medium areas" correspond to known or suspected ranges of distinct biological stocks. "Large areas" are typically ocean basins.

In the absence of information about rates of mixing among adjacent small areas, the basic "C" procedure will be applied to each independently. In practice, this will result in very low quotas, primarily because of the large variances of abundance estimates for small areas. Given some information about mixing among adjacent small areas, two processes were considered whereby small areas will be combined for abundance estimation and setting catch limits. In one process, termed "catch cascading," the catch limits set from the combined areas will be distributed to the small areas in proportion to the estimated abundances in those small areas. In practice, this will result in larger catch limits as compared to small areas that will be treated separately. The second process considered was termed "catch capping." For this process, the catch limits will be computed for both the medium (or large) areas and for the separate small areas. If the sum of the small area catch limits exceeds the medium area limit (possible, but not likely), the small area limits will be reduced proportionally by the ratio of the medium area limit to the sum of the small area limits. In the likely event that evidence for combining areas will be somewhat equivocal, the Committee agreed to conduct simulation trials to examine the apparent range of uncertainty to determine whether the combination will be appropriate.

The next difficult task of the Scientific Committee will be to begin implementing the Revised Management Procedure for minke whales in the North Atlantic and in the Southern Hemisphere. This will form the major part of the Committee's work at this year's annual meeting which will be held in Glasgow in June. Other matters on the agenda include an evaluation of the status of exploited populations of belugas and narwhals and a major reassessment of the baleen whales of the Southern Hemisphere (other than minkes, which were considered in 1990). If the Scientific Committee completes the job of providing minke whale catch quotas, it will be up to the Commissioners, whose meeting immediately follows, to deal with the political, social, economic and other considerations inherent in reopening commercial whaling. Iceland and Norway have threatened to withdraw from the IWC if it does not agree to this reopening, and Iceland has already formally filed its intention to leave effective June 30, 1992. (S. Reilly, [619] 546-7164).

COASTAL MARINE MAMMAL PROGRAM

Status of Pinniped Stocks Workshop Held at the Southwest Fisheries Science Center, April 1992

Since the initial passage of the Marine Mammal Protection Act (MMPA) in 1972, through 1987, permits authorizing the incidental take of nondepleted species of marine mammal stocks within the U.S.

Exclusive Economic Zone (EEZ) have been issued by the National Marine Fisheries Service (NMFS) to commercial fishermen. The 1988 amendments to the MMPA established the Interim Exemption Period. This legislation governs the taking of marine mammals during commercial fishing operations. This 5-year Interim Exemption expires on October 1, 1993. The NMFS is currently in the process of developing a new regime to govern the interactions between marine mammals and commercial fishing operations following the expiration of the Interim Exemption.

In preparation for the initiation of a new management regime, the NMFS is holding a series of workshops to review the status of marine mammal species that interact with U.S. fisheries. From April 27 to 30, the Southwest Fisheries Science Center (SWFSC) hosted the Status of Pinniped Stocks Workshop for the purpose of reviewing a number of stock-assessment documents on the following North Pacific pinnipeds: northern sea lion, northern fur seal, Pacific harbor seal, California sea lion, northern elephant seal, and the Hawaiian monk seal. Douglas DeMaster, chief of the Marine Mammal Division, chaired the workshop and a number of Marine Mammal Division scientists presented papers for review. Representatives from the NMFS Southwest Regional Office, National Marine Mammal Laboratory, NMFS Honolulu Laboratory, California Department of Fish and Game, Oregon Department of Fish and Game, Washington Department of Fish and Game, various universities, and other research organizations also contributed data and reports which were used in the assessment of these species. A final report is being prepared and will be available by September 1992. (J. Barlow, [619] 546-7178)

Project Summary for the Coastal Cetacean Aerial Survey, February-April 1992

An aerial survey to determine minimum winter abundances for coastal cetaceans off the coast of California was completed on April 6, 1992, by the Coastal Marine Mammal group. The project began on February 8, during an unusually rainy month. The aircraft used for the survey was a high-wing National Oceanic and Atmospheric Administration (NOAA) *DeHavilland Twin Otter* based out of Miami's Aircraft Operations Center. The survey was conducted by flying predetermined tracklines between the coast and approximately 100 nmi offshore, at an altitude of 700 ft and at a speed of 100 knots. Line transect methodology was used during the survey, with one observer searching from each side of the aircraft through bubble windows and a third observer searching through a window in the belly of the plane. The third observer recorded any cetaceans missed by the two primary observers. Due to adverse weather conditions, only 30 out of a possible 60 days were flown. An attempt to survey two overlapping grids, separated by approximately 25 nmi was made. Eighty-five percent of Grid 1 (5140.9 km) and 15 percent of Grid 2 (907.2 km) were completed. Figure 1 shows the transect lines that were completed during the survey, totaling 6048 km. A total of 105 cetacean sightings was recorded, encompassing 16 cetacean species (Table 1).

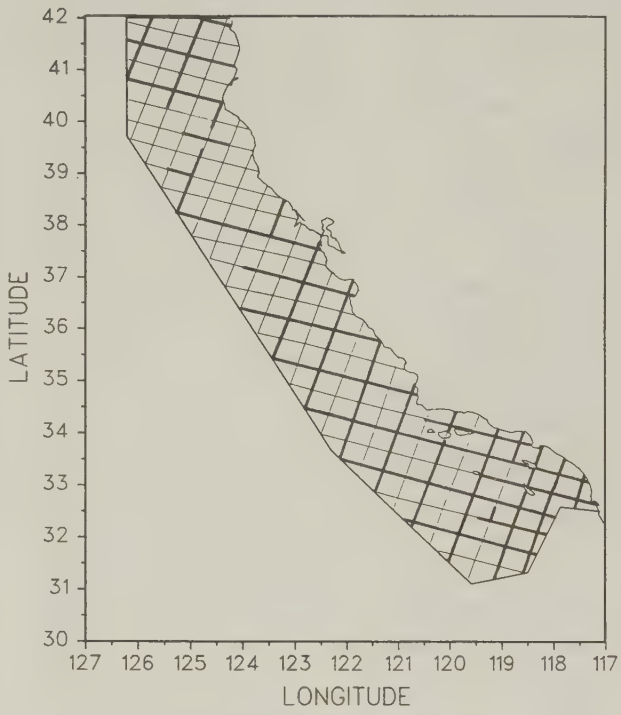

Figure 1. Transect lines that were flown during the California Cetacean Aerial Survey.

The objective of the survey was to determine minimum winter abundance estimates. To accomplish this, the data from the 1991 aerial survey will be analyzed along with the 1992 survey data. Sighting data will be analyzed for estimating minimum abundance for each species. Currently, data from last year's cetacean survey are being analyzed, and preliminary abundance estimates are being made for certain species, mainly small delphinids. Abundance estimates of larger species, such as rorquals and sperm whales, will be made from data collected in the fall of 1991 by the Southwest Fisheries Science Center (SWFSC) during the California Marine Mammal Survey aboard the NOAA ship *McArthur*.

Table 1. Cetacean species identified during California Cetacean Aerial Survey and the number of sightings of each species.

SPECIES	# SIGHTINGS (on effort)
Delphinus delphis	13
Grampus griseus	10
Globicephala spp.	1
Lissodelphis borealis	9
Lagenorhychus obliquidens	13
Phocoenoides dalli	18
Phocoena phocoena	6
Tursiops truncatus	3
Ziphius cavirostris	1
Balaenoptera acutorostrata	1
Balaenoptera musculus	1
Balaenoptera physalus	2
Eschrichtius robustus	10
Megaptera novaeangliae	3
Eubalaena glacialis	1
Physeter macrocephalus	2
D. delphis/ S. coeruleoalba	1
unidentified small delphinid/porpoise	1
unidentified whitebelly dolphin	3
unidentified small whale	1
TOTAL	97

Of special interest during the survey was one sighting of a North Pacific right whale, *Eubalaena glacialis*, that was made approximately 35 miles southwest of San Clemente Island on March 24. This whale was photographed with a KA-45 5-inch format camera located in the belly window of the aircraft. Preliminary imagery shows that the callosities on the whale are clearly visible. North Pacific right whale sightings are rare; there have been only two other sightings off southern California since 1988. One whale was sighted on February 5, 1988, from the Southwest Fisheries Science Center in La Jolla, California, and was viewed by many observers. On May 9, 1990, a right whale was seen eight miles off Catalina Island. This whale was photographed and videotaped by observers on board the Catalina Empress ferry. According to the National Marine Fisheries Service's "Recovery plan for the northern right whale, *Eubalaena glacialis*," published in 1991, there have been fewer than 90 reliable records of North Pacific right whales being sighted south of 50° N in the eastern North Pacific since 1850. Population estimates for North Pacific right whales are statistically weak due to the paucity of sightings; however, most estimates range between 100 and 500 whales.

One sighting of four pilot whales, *Globicephala* spp., was made approximately 40 miles southeast of San Nicolas Island. Sightings of pilot whales in California waters have been rare since the 1982-1983 El Niño, with only one other sighting reported in the fall of 1991 near the Farallon Islands. Two sightings of blue whales, *Balaenoptera musculus*, were made off southern California, and four sightings of fin whales, *Balaenoptera physalus*, were made in the Channel Islands region.

Sightings of pinnipeds along track lines were recorded only when the aircraft was farther than six miles from the mainland or islands. These sightings will not be used to estimate abundances but will be used to further study the offshore distributions and habits of these species.

A large format KA-45 camera was utilized during the survey to photograph cetaceans on an opportunistic basis. Eight schools of cetaceans were photographed for purposes of length measurements and stock identification. Aerial photographs of common dolphins, *Delphinus delphis*, will be analyzed and measurements taken in an effort to differentiate the larger inshore form from the smaller offshore form. Other cetaceans photographed include *Eschrichtius robustus, Lissodelphis borealis, Lagenorhynchus obliquidens, Physeter macrocephalus, Grampus griseus*, and *Eubalaena glacialis*. A report is currently being prepared for the Status of Cetacean Stocks Workshop which has been tentatively scheduled for September 1992. (J. Carretta, [619] 546-7181).

HONOLULU LABORATORY

Honolulu, Hawaii

INSULAR RESOURCES INVESTIGATION

Scientists Study Links Between Spiny Lobster Abundance, Production, and Bank Habitat

The production and abundance of Hawaiian spiny lobster, *Panulirus marginatus*, were examined recently in relation to the geomorphology and benthic habitat of banks in the Northwestern Hawaiian

Islands (NWHI). This study was initiated by Frank Parrish, fishery biologist, and Jeffrey Polovina, chief of the Insular Resources Investigation, to determine why, throughout the 15-year lobster fishery, certain NWHI banks have consistently yielded higher production, while neighboring banks of comparable size have yielded very little.

Parrish and Polovina compared the catch-per-unit effort (CPUE) from pre-exploitation research trapping (1971-81) with the summit depths of NWHI banks. They found that lobster abundance decreases as depth increases (Figure 1). Banks with summit depths greater than 30 m had low CPUE values. Based on this evidence, the scientists speculate that larval settlement is not significant at depths greater than 30 m.

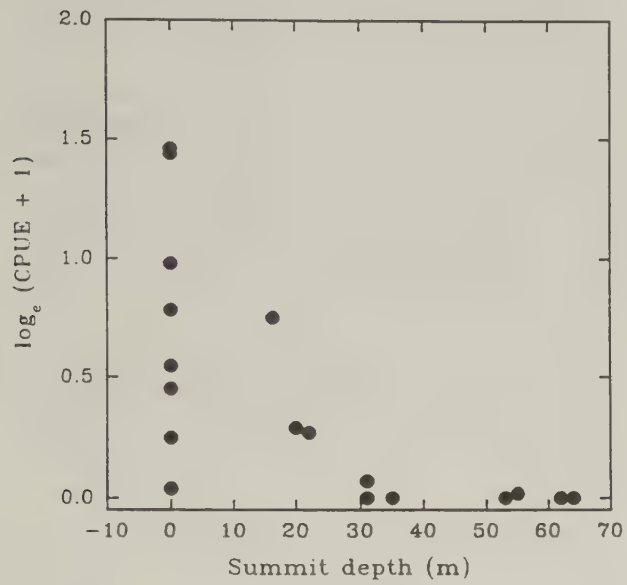

Figure 1. Pre-exploitation research trapping (1971-81) catch-per-unit-effort (CPUE) of lobster larvae compared with bank summit depth. Zero values indicate "at the surface."

Also examined were the CPUEs for sublegal and legal lobster in relation to location and bank substrate type; CPUE data were from the Honolulu Laboratory's annual lobster assessment cruises in 1990-91. The study sites included three similarly sized banks--the commercially productive fishing grounds of Necker Island and Maro Reef and the historically poor grounds of Lisianski Island. A total of 17 stations (1 for every 125 km^2 of bank area) was trapped and visually assessed by divers. The divers were towed at depths of 30-40 m for a mean distance of 2 km; every 90 seconds, they made systematic observations and took photographs. They recorded the percent cover of coral, sand, algae, even bottom, and substrate rugosity, which is an index of relief.

This study revealed that the bank habitats have a strong algal component with two obvious compositions, a short (<5 cm) homogenous algal turf and a taller (10 cm) multispecies aggregation. The only statistically significant correlations were for sublegal lobster CPUE with the substrate variables "rugosity" and "algal turf": Sublegal lobster were positively associated with rugosity and negatively associated with the algal turf (Figure 2). Such correlations were observed when the three banks were compared, but not when habitat types within a bank were compared.

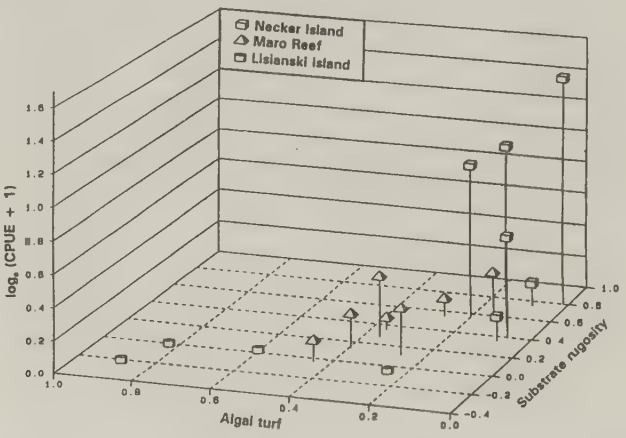

Figure 2. Correlations between the catch-per-unit effort (CPUE) of sublegal spiny lobster and indices of the substrate variables "rugosity" and "algal turf."

The absence of rugose habitat or the high abundance of "algal turf" at trapping depths at Lisianski Island may explain why this bank has failed to yield commercial stocks, despite its extensive shallow-water regions which might act as a nursery. The habitat at depths where adults are trapped likely plays a critical role in a bank's ability to support juvenile and commercial lobster populations. Such conclusions suggest that the benthic habitat at Lisianski Island could be enhanced to become commercially productive. (F. Parrish, [808] 943-1254)

Report Completed on Depth-distribution of Trawl-caught Opakapaka and Associated Fishes

The bottom trawl catches of juvenile opakapaka, *Pristipomoides filamentosus*, and associated fishes were described in a report recently completed by Edward DeMartini, leader of Insular Ecology

Study; Denise Ellis, biological technician; and Robert Moffitt, fishery biologist. The catches were from 80 bottom trawl hauls conducted from the NOAA ship *Townsend Cromwell* (cruise TC-90-10), November 12 to December 13, 1990, at 11 windward and leeward regions of Oahu, Molokai, Lanai, and Maui in the main Hawaiian Islands. Seventy-two of the 80 trawl hauls were considered quantitative (e.g., no gear was lost or damaged, the tow did not deviate from the desired bearing or depth). This research characterized the depth-distribution patterns of juvenile opakapaka and associated fishes.

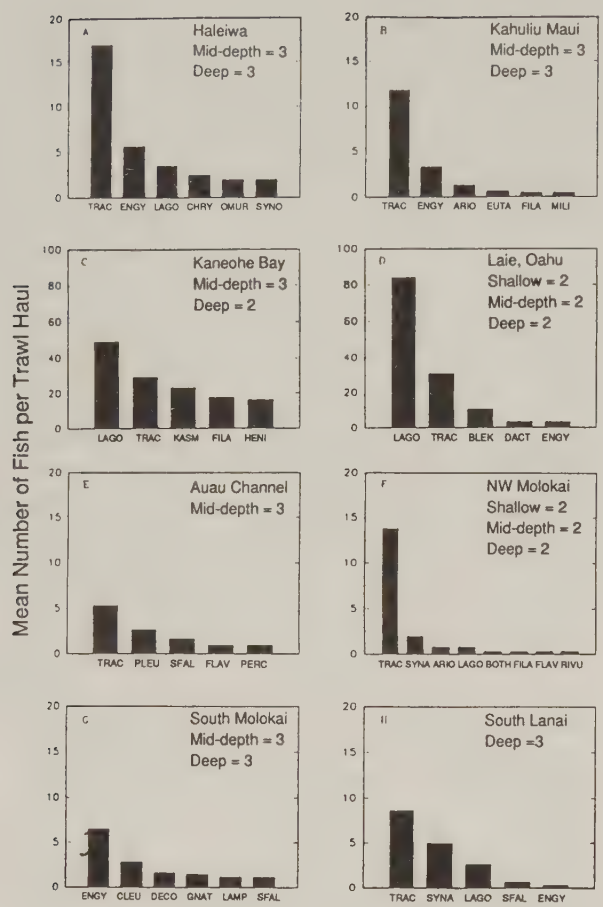

Figure 3. (A-H) Mean number of fish per trawl haul for top-ranked species in eight regions. Number of trawl hauls per depth is listed for each area. Shallow = 61 m; mid-depth = 76 m; and deep = 91 m. ARIO = *Ariosoma bowersi*; BLEK = *Bleekeria gilli*; BOTH = Bothidae (unidentified sp.); CHRY = *Parupeneus chrysonemus*; CLEU = *Chromis leucura*; DACT = *Dactyloptena orientalis*; DECO = *Callionymus decoratus*; ENGY = *Engyprosopon xenandrus*; EUTA = *Halieutaea retifera*; FILA = *Pristipomoides filamentosus*; FLAV = *Mulloides flavolineatus*; GNAT = *Gnatholepis anjerensis*; HENI = *Heniochus diphreutes*; KASM = *Lutjanus kasmira*; LAGO = *Lagocephalus hypselogeneion*; LAMP = *Canthigaster epilampra*; MILI = *Chaetodon miliaris*; OMUR = *Ophidion muraenolepis*; PERC = *Parapercis schauinslandi*; PLEU = *Parupeneus pleurostigma*; RIVU = *Canthigaster rivulatus*; SFAL = *Synodus falcatus*; SYNA = *Synagrops argyrea*; SYNO = Synodontidae (unidentified sp.); TRAC = *Trachinocephalus myops*.

Eighty-nine taxa of benthic and epibenthic fishes were captured. The three most commonly trawled benthic species were a synodontid, *Trachinocephalus myops*; a tetraodontid, *Lagocephalus hypselogeneion*; and a bothid, *Engyprosopon xenandrus* (Figure 3). The highest mean catch-per-unit effort (CPUE; number per trawl) was recorded from catches at Kaneohe Bay, Oahu (224 benthic fish per trawl in 5 quantitative trawls). The lowest CPUE was recorded at Lahilahi Point, leeward Oahu (3 fish per trawl in 3 quantitative trawls).

Juvenile opakapaka occurred in only 12 of the 72 quantitative trawl hauls; a total of 125 individuals was collected, 108 of these off Kaneohe Bay. Most juvenile opakapaka were caught at depths of 64-80 m. Length frequencies of opakapaka were bimodally distributed (Figure 4), indicating two age classes--ages 0+ and 1+.

The precision of the mean CPUE data from the hauls (for t-test of means, $\alpha = 0.05$ and power $[1 - \beta] = 0.8$) was found to be insufficient to detect 50 percent changes in the abundance of opakapaka or

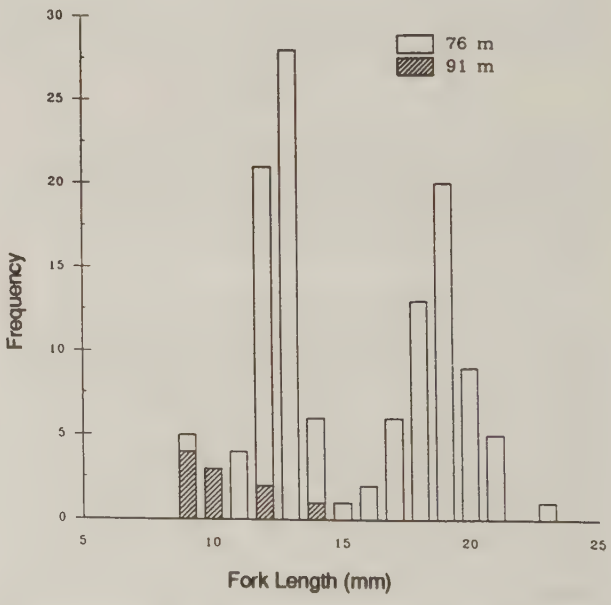

Figure 4. Length-frequency distribution for opakapaka by mean depth of capture (with regions combined).

any of the three most-commonly trawled species. Additional studies are being made to evaluate the abundance of juvenile opakapaka throughout the main Hawaiian Islands.

The report describing these results is available as Southwest Fisheries Science Center Administrative Report H-92-03. (E. DeMartini, [808] 943-1266)

Status of Armorhead Stocks on Seamounts Inside and Outside the U.S. Exclusive Economic Zone

Since 1985, the Honolulu Laboratory has been conducting annual, and sometimes seasonal, stock assessments of armorhead, *Pseudopentaceros wheeleri*, at Southeast Hancock Seamount. Southeast and Northwest Hancock Seamounts are in the extreme northwestern part of the Hawaiian Archipelago, just within the U.S. Exclusive Economic Zone (EEZ), and are part of the southern-Emperor-northern Hawaiian Ridge (SE-NHR) seamounts. The other SE-NHR seamounts with armorhead populations lie in international waters northwest of the Hancock Seamounts. Because of the depleted condition of the armorhead population at the Hancock Seamounts, a 6-year moratorium on seamount groundfish fishing was implemented there in 1986.

Seasonal and annual assessments of armorhead abundance at Southeast Hancock since 1985 have been based on depth-stratified mean catch-per-unit effort (CPUE) from research bottom longline sets. Since armorhead apparently cease somatic growth at the seamounts after recruiting from an extended pelagic phase, increases in armorhead CPUE should reflect increases in abundance due solely to recruitment. Biomass estimates of armorhead at Southeast Hancock (Figure 5) over the past 7 years have shown no evidence of recovery to estimated levels in excess of 1,000 metric tons (t) during most of the early 1970s. During this later period, a Soviet and Japanese bottom trawl fishery for armorhead extended throughout the SE-NHR seamounts, with the Hancock Seamounts contributing about 10 percent of the total catch. Continued access to catch-and-effort data from Japanese trawlers fishing the SE-NHR seamounts in international waters has allowed for monitoring of the principal fishing grounds of the historical fishery.

Trawling CPUE has remained depressed since its dramatic decline in the mid-1970s. During the last decade, trawling CPUE for armorhead at other SE-NHR seamounts has remained low (<1t/hour) compared to the 16.4 t/hour average for 1970-75. However, a recent change although modest, in Japanese trawling CPUE at the seamounts outside the U.S. EEZ is the first substantial increase in the last decade (Figure 6). Interestingly, increases in biomass at Southeast Hancock during 1986 and 1990 coincide with the only increases in the past decade of trawl CPUE at seamounts outside the U.S. EEZ.

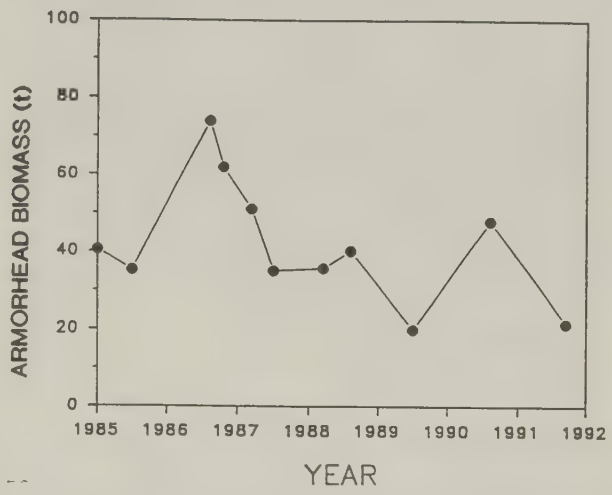

Figure 5. Biomass estimates (in metric tons) of armorhead at Southeast Hancock Seamount for each stock assessment survey conducted there by the Honolulu Laboratory since 1985. Estimates are shown for the appropriate month within the year in which the survey was conducted.

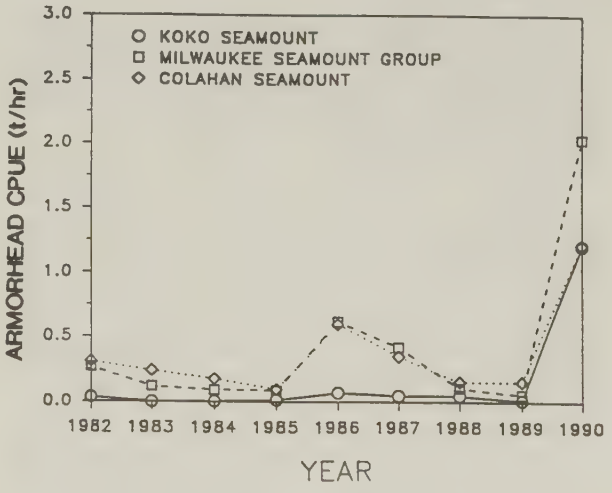

Figure 6. Annual mean catch-per-unit effort (CPUE) (in metric tons-per-trawling hour) of armorhead at each of the three principal seamounts outside the U.S. Exclusive Economic Zone (EEZ). Data were provided by Takashi Sasaki (National Research Institute of Far Seas Fisheries Research, Shimizu, Japan) and are based on catch records of the North Pacific trawl fishery of Japan.

Despite this most recent increase, however, armorhead stocks continue to remain at low abundance throughout the SE-NHR seamounts and may require a longer period for recovery than originally envisioned. This has prompted a 6-year extension of the current moratorium on groundfish fishing at the Hancock Seamounts, which was due to expire this year. Although the moratorium is only a modest step toward recovery of the SE-NHR armorhead resources, it may serve to encourage efforts toward international management of the SE-NHR seamounts outside the U.S. EEZ. Until this is realized, the moratorium will continue to provide a potential brood stock refuge and the only sustained attempt at reviving a once productive fishery which yielded a combined catch of some 880,000 t of armorhead from the SE-NHR region during 1969-75. (R. Humphreys, [808] 943-1229)

PELAGIC RESOURCES INVESTIGATION

Scientists Study Tuna in a Swim Tunnel

Scientists are using a swim tunnel to study tuna in captivity at the Honolulu Laboratory's Kewalo Research Facility. The swim tunnel adds a new dimension to tuna research: It allows scientists to monitor the performance of individual tuna during experiments lasting more than 35 hours. Previously, tuna could be monitored for only a few hours before they died.

The swim tunnel (Figure 7) was designed and built by Jeff Graham, the director of the Marine Biology Research Division at Scripps Institution of Oceanography in La Jolla, California.

Graham's swim tunnel looks like something out of a science fiction novel. The tunnel has a four-foot-long sealed box where a fish can swim freely while it is being studied. Seawater is recirculated through the box via large plastic pipes extending from either end. The flow of the seawater is controlled by an electric motor and a propeller.

The tunnel is similar to a treadmill: the tuna remains in one location while swimming against the flowing current within the sealed box. This "tuna treadmill" enables scientists to measure how well tuna perform at different swimming speeds, temperatures, and oxygen levels.

Because tuna can be maintained for long periods in the swim tunnel, the device gives the fish the few hours it needs to adjust to its environment before an experiment is begun. Without this adjustment

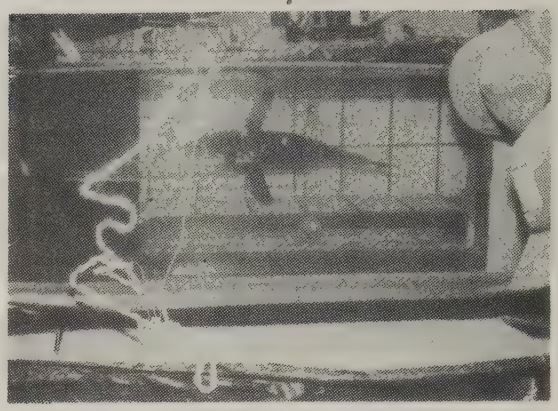

Figure 7. Swim tunnel used to study tuna in captivity at Honolulu Laboratory's Kewalo Research Facility.

time, the data recorded for the fish would not be representative. Tuna must swim continuously, holding their mouths open to obtain oxygen as the water passes over their gills. If they stop swimming, they will sink and suffocate.

Graham brought his swim tunnel to Hawaii because Honolulu Laboratory scientists had developed the techniques for maintaining and studying tuna in captivity. Nowhere else in the world is this type of research being successfully done.

Graham stressed that the project would not have been possible without the advice and the special handling techniques perfected by Honolulu Laboratory Fishery Biologists Richard Brill and Randy Chang, as well as the assistance of Laboratory Director George Boehlert.

The present studies by Graham, along with graduate students Torre Knower and Keith Korsmeyer of Scripps, are examining how the skin, muscles and heart of yellowfin tuna, *Thunnus albacares*, affect performance.

Tuna, like race horses, are high-performance animals with correspondingly high metabolic demands, a large heart, and high oxygen demands. Tuna are always being pushed to the limit: their barren environment has limited food and large predators; they are exposed to different levels of temperature, oxygen, and light at differing depths as they move through the ocean hunting for prey and escaping from predators.

Graham believes it is important to understand how the performance of tuna relates to their natural history--their vertical movements in response to changes in environment, temperature, food, and

salinity. Understanding the physiology of tunas can reveal the type of environment where tuna will be found, information that is important to fishermen and fishery managers. For his present work, Graham received funding from the National Science Foundation. (R. Brill, [808] 943-1234)

FISHERY MANAGEMENT AND PERFORMANCE INVESTIGATION

Pacific Pelagic Fisheries Planning Conference

The Pacific Pelagic Fisheries Planning Conference was held in Honolulu March 25-27, 1992, at the East-West Center's Jefferson Hall. The conference was sponsored by the University of Hawaii's School of Ocean and Earth Science and Technology (SOEST), with funding and support from National Marine Fisheries Service and the Western Pacific Regional Fishery Management Council. Tuna and billfish scientists from throughout the United States and the Pacific were invited to attend. The primary purpose of the conference was to chart directions for allocating a special congressional appropriation of $1.7 million annually for 5 years.

The conference began with plenary reviews of recent research developments by experts in fishery oceanography and biology, tuna stock assessment, tuna and billfish interactions, and social science. The next day was dedicated to working groups on these topics to identify the important activities for tuna and billfish research in the western Pacific. On the final day, the priorities across disciplines were established. The results of the conference are being compiled in a report to be released shortly in conjunction with a solicitation by SOEST for research proposals on these topics.

Participation from the Honolulu Laboratory included George Boehlert, Jerry Wetherall, Robert Skillman, Christofer Boggs, and Samuel Pooley; and from La Jolla, Izadore Barrett and Gary Sakagawa. (S. Pooley, [808] 943-1216)

PROTECTED SPECIES INVESTIGATION

Testosterone-suppressing Drug Studied in Monk Seals

Protected Species Investigation (PSI) researchers are studying the effects of a testosterone-suppressing drug (Decapeptyl-CR) on the behavior of captive Hawaiian monk seals, *Monachus schauinslandi*, reported William Gilmartin, PSI chief. This research is evaluating the drug's potential as a temporary solution to the mobbing problem. A "mobbing" is when a number of adult males simultaneously attempt to mate with adult females or immature seals of either sex, usually causing serious injuries and often death from the injuries themselves or indirectly by subsequent shark attacks on injured animals.

As part of this research effort, adult male seals housed with an adult female were administered the testosterone-suppressing drug once the males exhibited sexual interest and guarded the female. Behavioral observations are being made to track the males' interest in the female and any aggressive interactions. The outcome of this work, and a pilot field study with the drug this summer, will be used to determine whether this research will be further expanded in the field in fiscal year 1993.

Two recent manuscripts contributed to evaluation of the drug's potential effects on the behavior of monk seals. One manuscript shows the capability of the drug to reduce plasma testosterone to castrate levels: "Testosterone response to a gonadotrophin-releasing hormone agonist in Hawaiian monk seals," by Shannon Atkinson, Gilmartin, and Bill Lasley, which was accepted for publication in *Journal of Reproduction and Fertility*. The other manuscript, which is being reviewed, shows the ability of the drug to suppress aggressive behavior: "Effects of a GnRH-agonist on socio-sexual behavior and plasma testosterone concentrations in harbor seals, *Phoca vitulina*," by Pam Yochem, Atkinson, and Gilmartin. (W. Gilmartin, [808] 943-1239)

Monk Seal Population Declines at French Frigate Shoals

The first atoll-wide beach count of Hawaiian monk seals at French Frigate Shoals (FFS) in March 1992 was 144 seals (excluding pups). This is down from the 188 seals counted last year during a comparable time period; it is also below the 1991 mean of 191 (range, 159-238). These data, together with the observation of a high proportion of emaciated juveniles at FFS, suggest the stress on that population recorded during 1990-91 continues. An investigation team--including William Gilmartin, Honolulu's Protected Species Investigation Chief; a veterinarian; and a virologist--visited FFS during April 9-10, 1992, to examine and collect specimens

from emaciated and apparently normal juvenile monk seals. The trip was arranged after a report of low numbers of juvenile seals in the beach counts, with a high fraction of juveniles appearing thin to emaciated.

Examinations of 19 juveniles--together with the results of blood counts, serum chemistry profiles, negative serum antibody titers to canine distemper and *Leptospira*, and stool cultures for *Salmonella* (two positives, an expected finding)--indicate preliminarily that infectious disease is not the cause of the observed changes in the number and condition of the seals. Extensive follow-up viral culture and parasitological examinations are being performed.

The next step is to collect and transport some of these emaciated juveniles to Honolulu for rehabilitation and to perform some additional serological testing and biopsies for toxicological assays. After being rehabilitated, these animals, when appropriate, will be released at another site (probably Midway Islands) where the monk seal population is highly depleted, but where food resources are probably sufficient to support the additional seals. Should the seals do well at such a site, without significant intervention or treatment other than feeding, the finding will support the assumption that FFS prey resources are low. (W. Gilmartin, [808] 943-1239)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

Quick Access to Comprehensive Ocean Atmospheric Data Set

As a contribution to the Climate and Eastern Ocean Systems (CEOS) program, the Quick Access to Comprehensive Ocean Atmospheric Data Set (COADS) is available on microcomputer at Pacific Fisheries Environmental Group (PFEG). The CEOS Program is a NOAA-Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM)-International Center for Living Aquatic Resources Management (ICLARM) cooperative project supported by the NOAA Climate and Global Change Marine Ecosystem Response Project and by the Terre Ocean Atmosphere (TOA) Department of ORSTOM. This data set allows quick access to oceanographic and meteorological parameters from the world's oceans. Data for any region of the oceans are quickly obtained and then easily imported into commercial spreadsheet and graphics packages to provide additional editing and/or a graphical display of the data. The process of making these data available involved three steps: collection of the data, reorganization of the data, and the development of computer software to provide access to the data.

Monthly means of ship observations by a 2° square of the ocean for the years 1946-1987 were obtained from the World WeatherDisc on CD-ROM. This COADS data set is a subset of the extensive meteorological data base acquired from the archives of the National Climatic Data Center and the National Center for Atmospheric Research (NCAR). Parameters obtained were air temperature, sea surface temperature, surface wind in the north-south and east-west directions, sea level pressure, and the number of observations in each 2° location.

COADS data for the years 1988-1990 were obtained directly from NCAR with the assistance of Steve Worley. The data were transferred from a SUN workstation at NCAR through an Internet line to a MAC II at PFEG.

The COADS data were then distributed into files that contain data for each 10° by 10° location. The associated 10° Marsden Squares box number was included in the assignment of the filename. This allows for almost immediate location of the data, given any longitude and latitude values. Each file was stripped of any blank records and converted to binary files to save storage space. The entire set of binary files is roughly 80 megabytes in size.

The CODE2 program, written at PFEG Portable Fortran, is used to retrieve the reorganized data. The user indicates a region of the ocean for which data is desired. This is defined by entering a set of longitude and latitude values, each set of which defines a rectangle of 2° boxes. The defined region may consist of a single box or a complex staircase of 2° boxes along a coastline. Output from the CODE2 program consists of annual and monthly output files and a binary file of the selected data. The annual output file shows the 12 monthly means of a single parameter for a year, by parameter (Figure 1). The monthly output file shows all 5 parameters for a year, by month (Figure 2). Data is comma delimited in each output file allowing for easy import into existing software packages including EX-

	Label A	C	D	E	F	G	H
Label	YEAR	JAN	FEB	MAR	APR	MAY	JUN
1		0.64	2.77	4.83	2.46	3.87	3.42
2	1947	3.7	0.92	2.41	2.5	4.67	3.22
3	1948	0.74	0.86	2.62	1.68	4.4	3.38
4	1949	0.95	1.55	2.42	2.28	2.3	2.53
5	1950	1.55	1.42	2.75	2.49	2.69	2.76
6	1951	3.01	2.1	1.93	1.83	3.13	2.12
7	1952	2.91	1.63	3.76	2.25	2.14	3.19
8	1953	2.36	1.45	3.1	2.49	3.26	3.31
9	1954	3.11	1.32	2.51	2	2.42	3
10	1955	2.13	0.47	0.9	2.71	2.38	3.05
11	1956	1.78	1.13	2.21	3	2.61	3.09
12	1957	1.01	0.04	2.58	2.63	4.05	3.21
13	1958	1.95	2.24	3.08	3.66	1.15	2.79
14	1959	1.3	2.48	2.3	1.97	3.02	3.52
15	1960	1.88	2.52	2.23	3.18	3.43	1.92
16	1961	0.42	2.25	3.92	2.67	3.41	2.69
17	1962	0.89	2.76	2.7	2.72	2.96	2.72
18	1963	-0.31	2.03	3.22	3.86	2.81	2.68
19	1964	2.6	0.43	3.03	2.41	2.94	3.22
20	1965	1.52	1.19	1.93	2.45	3.28	2.8
21	1966	2.16	1.12	1.32	1.72	2.12	2.8
22							

Figure 1. Sample of an annual output file of oceanographic and meteorological parameters generated from the CODE2 program.

	Label	A	B	C	D	E	F
Label	YEAR	MONTH	EW-COMP	NS-COMP	ATM. PRES.	AIR TEMP	SST
1	46	1	6.38	-49.71	12431.71	1356.05	1435.64
2	46	2	27.72	-5.61	12088.67	1308.06	1333.65
3	46	3	48.33	-56.56	12087.89	1222.5	1288.39
4	46	4	24.57	-53.62	12028.86	1311	1308.52
5	46	5	38.68	-42.26	11733.79	1379.16	1442.83
6	46	6	34.17	-51.83	12106.42	1627.92	1516.33
7	46	7	18.14	-53.43	11895.42	1730.93	1717.4
8	46	8	17.53	-61.67	11811.35	1702.71	1818.93
9	46	9	10.83	-49.94	11540.28	1773.94	1794.5
10	46	10	35.8	-64.8	11535.3	1595.5	1623.82
11	46	11	27.54	-69.23	12152.33	1462.75	1528
12	46	12	-4.5	14.21	11651.64	1371.79	1371.21
13	47	1	37	-49.29	11762.79	1239.29	1363.5
14	47	2	9.17	-27.06	11882.35	1253.33	1379.89
15	47	3	24.08	-26.38	12222.15	1407.92	1481.08
16	47	4	25	-23.06	11945.12	1494.06	1490.38
17	47	5	46.71	-44.07	11795.5	1360.57	1376.21
18	47	6	32.21	-30.68	11511.74	1626.21	1607.21
19	47	7	31.1	-58.5	12049.8	1773.68	1646.35
20	47	8	24.05	-50.05	11547.77	1792.23	1803.67
21	47	9	22.4	-51.05	11675.78	1776.85	1810.55
22	47	10	31.85	-34.9	11845.6	1793.35	1819.15
23	47	11	21.79	-49	11934.57	1505.26	1580.05
24	47	12	10.42	-25.5	12246.45	1345.17	1399.85
25	48	1	7.43	0.57	12144.16	1381.05	1416.7
26							

Figure 2. Sample of a monthly output file of oceanographic and meteorological parameters generated from the CODE2 program.

CEL and Deltagraph. Figure 3 and Figure 4 show graphic output from the Deltagraph program.

The CODE2 program runs on both MAC II and DOS PC computers. A special version of the program also produces output in Hierarchic Data Format that can be input into programs such as the SPYGLASS programs for scientific visualization of data.

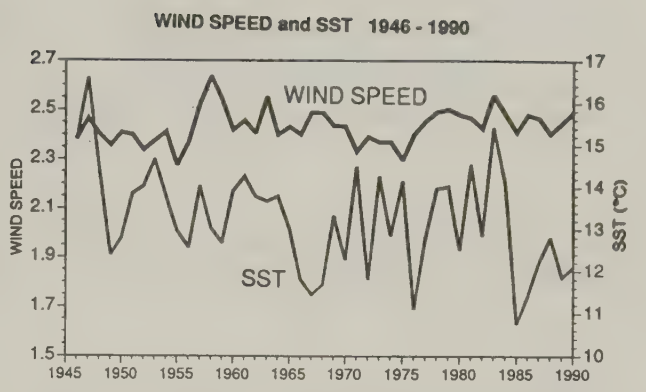

Figure 3. Sample of wind speed and sea surface temperature (SST) for long. 130° to 120° W and lat. 30° to 40° N from 1946 to 1990. Heavy line represents wind speed and light line represents SST sample.

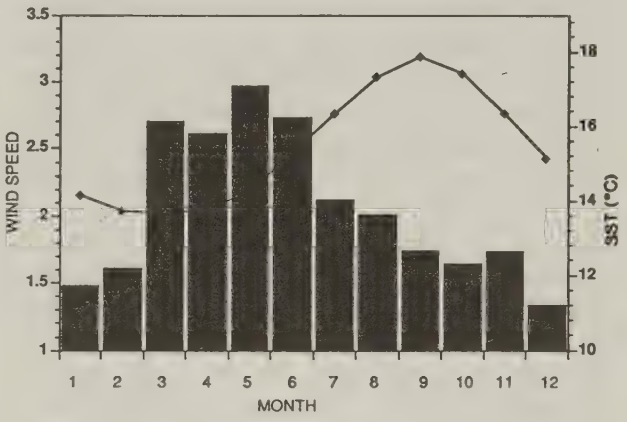

Figure 4. Sample of mean seasonal cycle by month for long. 130° to 120° W and lat. 30° to 40° N from 1946 to 1990. Bars represent wind speed sample and line represents sea surface temperature (SST).

PFEG is currently creating programs and reorganizing the raw data values for the COADS data set (rather than just the 2° by 2° mean values). The entire data set has been downloaded directly from NCAR through the Internet line with the help of Steve Worley. In all, more than 2 1/2 gigabytes of data were transferred. The data are stored on <5 magnetic optical disks, each of which contains about 220 megabytes per side. The data are currently being reorganized into files containing data for 2° by 2° boxes. Before this reorganization, access to the COADS data set was available only on a main frame computer and was a slow and tedious process. Additional programs are being developed to allow scientists quick access to this meteorological data set. (R. Mendelssohn, C. Roy, C. Curtis, [408] 646-3311)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

1991 Billfish Angler Survey

The Southwest Fisheries Science Center is preparing to conduct the annual Billfish Angler Survey. This Survey, started in 1969, is now in its 23rd year of operation. The objective of the Survey program is to collect angler catch-and-effort data to determine the trend of fishing in terms of catch rates for the recreational segment of a Pacific-wide resource. The other fisheries, which are commercial in nature, are the longline and drift-gillnet fisheries which are by far the larger takers of billfish (blue, striped, and black marlin; sailfish; shortbilled spearfish; and swordfish). The recreational fisheries, though not the major producer in terms of tonnage, are very important economically in many areas of the Pacific. Examples of this are the recreational billfish fishery around the southern tip of Baja California (Cabo San Lucas area), Mexico, and around the Hawaiian Islands. Tourism is very important to the economy of these areas, and although many people who visit these areas may not fish for billfish, the thought that it is possible to catch a large billfish is part of the attraction. If the recreational billfish catch rates decline to a low level, the image of these areas may be degraded leading to a loss of tourists.

In 1990, the total number of billfish fishing days in the Pacific, Indo-Pacific, and Indian Oceans reported by those anglers responding to the Survey was 15,606. Anglers responding to the survey reported catching 5,827 billfish in the Pacific. The catch rate for the Pacific was 0.42 billfish/day. For geographic locations having over 100 respondents, increases in catch rates were noted for striped marlin fished off Baja California, Mexico; Ecuador; and New Zealand. Increases in the catch rate for Pacific sailfish off Guatemala, and off Kenya in the Indian Ocean, were also seen. Increases were noted for blue marlin and black marlin off Guam and Australia respectively. Declines in the catch rate were noted for striped marlin off southern California; for Pacific sailfish off Acapulco, Mexico, and Costa Rica; and for blue marlin off Hawaii. (J. Squire, Jr., [619] 546-7072)

Tracking Striped Marlin in Cabo San Lucas, Mexico

Fishery Biologist Dave Holts traveled to La Paz and Cabo San Lucas, Mexico, in March for a 2-week striped marlin tagging study. This cooperative research included tagging striped marlin with sonic transmitters in order to track their horizontal and vertical movements. Mexican colleagues included Dr. Arturo Muhlia of Centro de Investigaciones Biologias (CIB) and several scientists from Centro Interdisciplinario de Ciencias Marinas (CICIMAR) who participated in the planning and operation of the study. The objective was to document striped marlin movements, sea temperature preferences, and daily cycles in an area of relatively high abundance. This information can provide insights into the vulnerability of the marlin to various types of commercial and recreational fisheries.

Tagging and tracking were conducted in Cabo San Lucas from CICIMAR's new 28 ft, 250 hp research boat. Over the 10 days of fishing, three striped marlin were tagged and tracked for periods of up to 9 hours. The marlin tracked for 9 hours descended to 35 m when released. It stayed between 30 and 50 m for the first 1.5 hours then descended to 80 m before it ascended to the surface. It remained between 0 and 40 m until just after sunset, when it again descended to 80 m. The signal from the fish was lost at 9:00 p.m. due to electronic problems in the receiver. The fish moved south during the entire track covering 10 nm in the 9 hours tracked. Average speed was 1.11 knots. This fish was reported caught and released by a local fisherman the following day, indicating its health had not been compromised by the tagging process.

Several problems occurred during the study; the most serious was in the boat's electrical system. This resulted in a malfunction of the tracking equipment and ultimately in the loss of all three tagged marlin.

The researchers at both CIB and CICIMAR are optimistic regarding additional research and have invited Holts back to La Paz in the fall to continue the project. (D. Holts, [619] 546-7186)

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

Seychelles Purse Seine Data Updated

Gary Rensink, biological technician, has completed updating the fourth quarter 1991 Seychelles Fishing Authority data from tuna purse seiners fishing in the western Indian Ocean. Data are summarized in LOTUS spreadsheets and cover the period 1983 to the present.

The number of vessels participating in the purse-seine fishery in the western Indian Ocean during the final quarter of 1991 reached a record high of 54 in November (17 French, 19 Spanish, 11 Japanese, 3 Mauritian, 2 from Seychelles, and 1 each from Panama and the USSR), compared to a high of 43 vessels recorded for the same period last year. The total number of purse seiners that participated in the fishery during the year declined for the first time since 1986, from 63 vessels in 1990 to 58 vessels in 1991 (Figure 1).

Fourth quarter catch rates in 1991 averaged 15 t (metric ton)/day, significantly lower than the average of 20 t/day rates for the same period in 1990 (Figure 2). Catch rates of 8 t/day for 1990 and 1991 were identical for yellowfin and for skipjack. The overall catch rate for December 1991 (6 t/day) was the lowest recorded since June 1984 when 5 t/day was recorded. Overall catch rates for 1991 (17 t/day) were the same as those for 1990.

Preliminary estimates of the cumulative catch for 1991 were 208,528 t, a decrease of 6 percent below

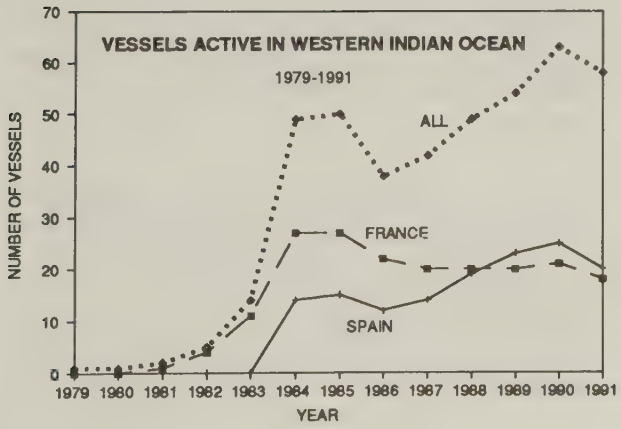

Figure 1. Number of French, Spanish, and all purse seiners that participated in the west Indian Ocean tuna fishery by year, 1979-1991.

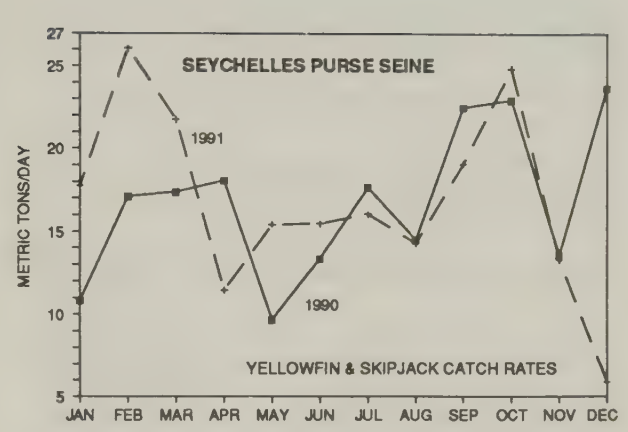

Figure 2. Catch rates (metric tons/day fished) for purse seiners fishing in the western Indian Ocean, 1990-1991.

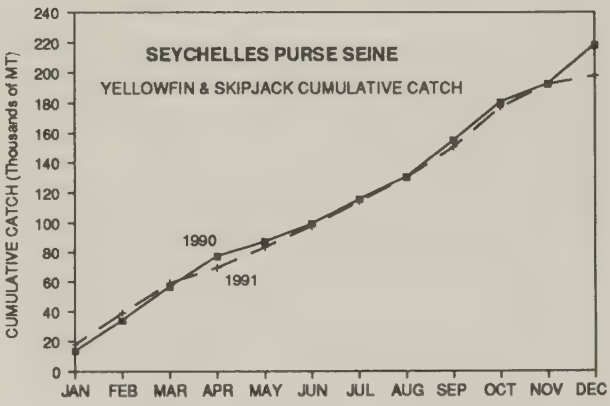

Figure 3. Cumulative catches (metric tons) of yellowfin and skipjack tuna by purse seiners in the western Indian Ocean, 1990-1991.

catches recorded for 1990 (Figure 3). The breakdown of tuna catch for the fourth quarter of 1991 was 21 percent yellowfin, 73 percent skipjack tuna, and 6 percent other tuna compared to 52 percent yellowfin, 47 percent skipjack tuna, and 1 percent other tuna during the same period in 1990. Skipjack comprised 77 percent of the catch in October and November 1991. The breakdown of tuna catch for 1991 was 45 percent yellowfin, 50 percent skipjack, and 5 percent other tuna compared to 46 percent yellowfin, 52 percent skipjack, and 2 percent other tuna in 1990. (Gary Rensink, [619] 546-7192)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH ANALYSIS INVESTIGATION

Late Larval Rockfish Surveys Completed

A research cruise aboard the research vessel *David Starr Jordan* was recently completed by investigators at the Tiburon Laboratory. The cruise (DSJ-92-03) extended from February 19 to March 8, 1992. The goal of the cruise was to determine the distribution and abundance of pelagic-staged late larval rockfish (*Sebastes* spp.) inhabiting the waters offshore the central California coast. The area surveyed (Figure 1) was from Monterey Bay (36° N) to Pt. Reyes (38° N), to a distance 170 nmi offshore (126° W).

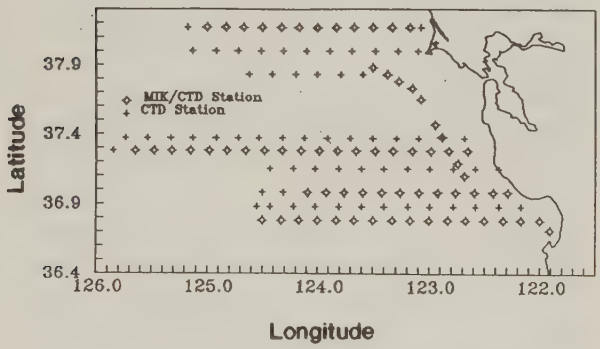

Figure 1. Methot Isaacs-Kidd (MIK) net and conductivity-temperature-density (CTD) sampling grid during *David Starr Jordan* cruise DSJ-92-03.

Three types of plankton and micronekton nets were used to capture the 5-20 mm rockfish. By the end of the cruise, 86 Methot Isaacs-Kidd (MIK) net tows, 21 multiple opening/closing net and environmental sensing system (MOCNESS) tows, and 6 California Cooperative Oceanic Fisheries Investigations (CalCOFI) bongo net tows had been completed. Rockfish were found in most of the samples, indicating a wide distribution that extended well off the continental shelf. During the cruise, it was apparent that samples taken at offshore stations contained a preponderance of small larvae, suggesting they had been transported directly offshore by prevailing currents.

During the cruise, 150 conductivity-temperature-depth (CTD) casts were completed. Results obtained from the new SeaBird thermosalinograph surface-profiler showed a pattern of anomalously warm water near the coast, consistent with the occurrence of an El Niño (Figure 2). Likewise, preliminary examination of CTD data indicated a deep thermocline in the nearshore area. It is possible that intrusion of coastally trapped warm southern waters into the nearshore region displaced the *Sebastes* larvae offshore.

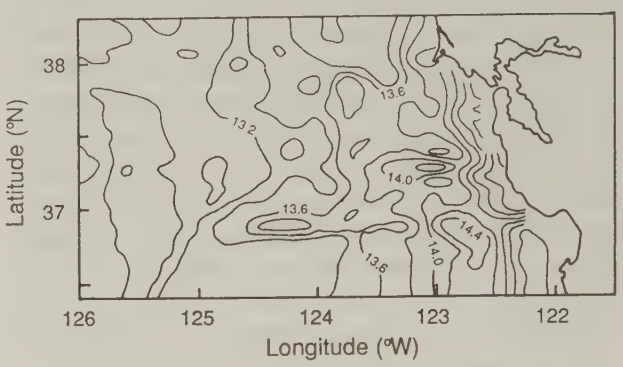

Figure 2. Contour plot of thermosalinograph sea surface temperature (°C) observed during *David Starr Jordan* cruise DSJ-92-03 (February 21-March 6, 1992).

Fishery Biologist David Woodbury also participated in a second ichthyoplankton survey aboard the Scripps Institution of Oceanography research vessel *New Horizon*. This cruise extended from March 14 to 28 and was part of the Center's FORAGE program, a study designed to investigate fishery oceanography of rockfish, thornyheads, Dover sole, and sablefish. During the cruise, a total of 46 stations along four offshore transects that lay north of Monterey Bay (37°00' N) and south of Point Arena (38°30' N) was sampled with a 10 m^2 multiple opening/closing net and environmental sensing system (MOCNESS) trawl. The most westerly stations were situated about 300 nmi offshore.

The MOCNESS used during the cruise contained 10 nets, each constructed of a 4-mm mesh body and a 505-m mesh cod end. When deployed, the MOCNESS could potentially collect up to nine discrete depth samples during a single tow. In this study, however, five depth strata were sampled at each station (0-50, 50-100, 100-200, 200-400 and 400-600 m), in addition to an integrated oblique sample taken during descent. A CTD mounted to the frame recorded temperature and salinity throughout each tow. A manta tow (505-m mesh) was also taken at each station to sample the neuston.

The catch of larval and juvenile rockfish during the research vessel *New Horizon* cruise was remarkably low, possibly due to mortality induced by warm El Niño conditions. Most of the rockfish that were caught were taken within 100 m of the surface. Results presented in Figure 3 show the locations of 43 of the 46 MOCNESS trawl stations, superimposed over contoured values of sea surface temperature (°C). Also provided is the total catch of *Sebastes* spp. from all MOCNESS nets. Because no rockfish were captured west of 127° W longitude, all 12 of the stations occurring in that portion of the study area were not included in the map. Results show that most of the rockfish came from the boundary region separating warm coastal waters and offshore California Current waters. Intuitively, one might expect to collect more fish in nearshore waters relative to offshore because parturition occurs over the continental shelf. However, as was indicated in the first survey, there is evidence that fish were advected offshore toward this boundary.

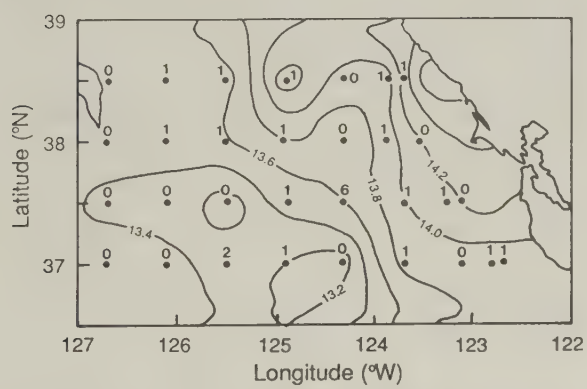

Figure 3. Contour plot of sea surface temperature (°C) observed during *New Horizon* cruise (March 14-28, 1992) showing locations of multiple opening/closing net and environmental sensing system samples and catches of *Sebastes*.

In spite of the overall low catch rate of rockfish in the MOCNESS, 81 *Sebastes* larvae were collected from the 100-fathom station at the eastern terminus of the most northerly transect. These fish were small, recently released larvae (4-7 mm TL), and it is likely that the majority of the fish entering the net escaped due to its coarse mesh.

At the standard stations, the manta net captured over twice the number of rockfish (50) than did the MOCNESS (24). However, the manta samples were almost exclusively composed of splitnose rockfish, *S. diploproa*, and one unidentified species, possibly stripetail rockfish (*S. saxicola*). Based upon information gained from the Laboratory's midwater trawl surveys, these two species comprise a small percentage of the rockfish captured below the neuston. (S. Ralston and D. Woodbury, [415] 435-3140)

GROUNDFISH COMMUNITIES INVESTIGATION

Nearshore Habitats at Santa Catalina Island Show Evidence of El Niño

Nearshore habitats at Santa Catalina Island, under study by the Groundfish Communities Investigation since 1972, were showing effects of unusually warm water when assessed by Ted Hobson, Tony Chess, and Dan Howard from April 13 to 15, 1992. As a result of strong recruitment during

Figure 4. Deterioration on *Macrocystis pyrifera* near the surface at Santa Catalina Island, April 15, 1992.

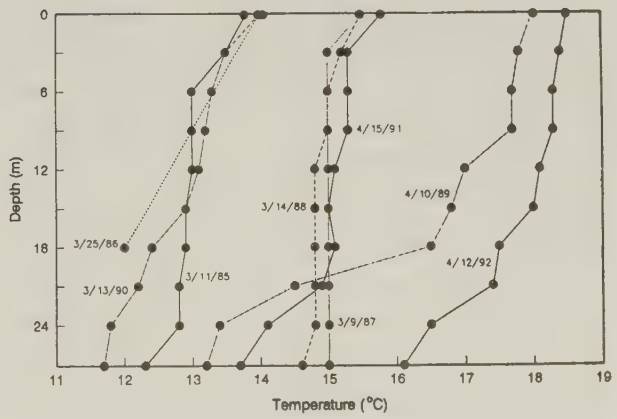

Figure 5. Sea temperatures in the upper 27 m of the water column at Santa Catalina Island during one day of March or April, 1985 to 1992.

1991, the beds of giant kelp, *Macrocystis pyrifera*, at sites around Ship Rock and Bird Rock were more extensive than at any time since being completely obliterated during the El Niño of 1982-83. Despite appearing healthy at lower levels of the water column, however, most of the sporophytes were to some extent deteriorated within about 5 m of the surface (Figure 4). Water temperatures were higher to greater depths than measured during any other March or April since 1985 (Figure 5), and drifting fragments of rotted kelp were numerous enough to affect visibility.

There is as yet no evidence of decline in various sessile invertebrates that suffered extensively during the 1982-83 El Niño, e.g., the tunicate *Tridemnum opacum* and the hydroid *Sertularella turgida*. Nor was there an obvious decline in surf perches that had abandoned the shallower reefs during the earlier warm-water event, e.g., *Brachyistius frenatus* and *Embiotoca jacksoni*. There had been movement of rockfishes into deeper water, however, as species of *Sebastes*, e.g., *S. atrovirens* and *S. serriceps*, became abruptly evident below about 17 m. (E. Hobson, J. Chess and D. Howard, [415] 435-3140)

Size of Commercial and Recreational Lingcod Landings Compared

In management of lingcod, *Ophiodon elongatus*, it is important to distinguish the commercial and recreational fisheries because each targets a different segment of the population. The commercial landings are composed of larger fish, with more of them being female, whereas the recreational landings are composed of smaller fish, with more of them being male. Kelly Silberberg and Pete Adams compared landings of these two fisheries from 1980 to 1989 using data from the National Marine Fisheries Service Marine Recreational Fishery Statistics Survey (for the recreational fishery) and from the Pacific Fisheries Information Network data base (for the commercial fishery). Their comparison shows that during this period, recreational landings were nearly equal to commercial landings off California (recreational landings were actually greater in the southern part of the state), and recreational landings in Oregon and Washington were equal to only about 19 percent of the commercial landings (Figure 6). Modeling studies are planned to further investigate problems involved in managing species exploited by multiple fisheries that target different segments of the population. (K. Silberberg and P. Adams, [415] 435-3410)

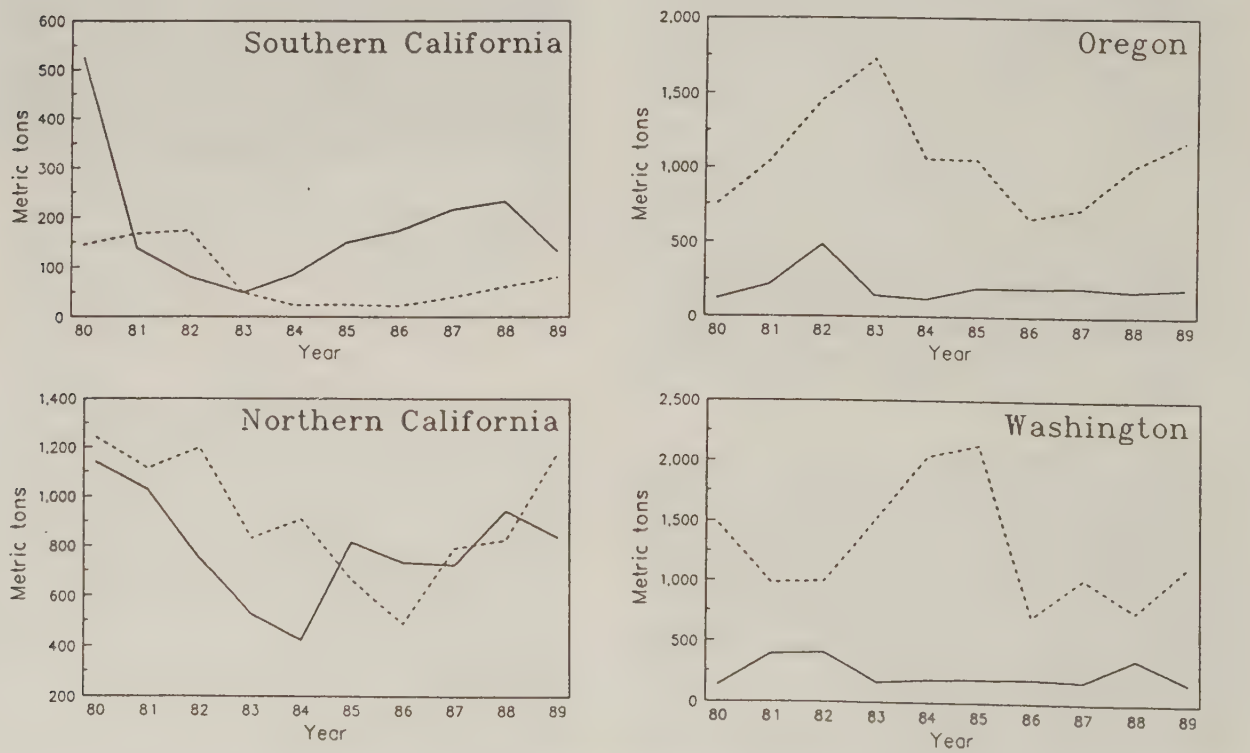

Figure 6. Comparison of recreational and commercial landings off southern California, northern California, Oregon, and Washington. The broken lines are commercial landings and the solid lines are recreational landings.

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Experiment Confirms Maternal-Embryonic Transfer of Phospholipids in Yellowtail Rockfish

As reported previously, serum and tissue measurements of nutritional variables during the annual reproductive cycle in yellowtail rockfish, *Sebastes flavidus*, suggest that certain nutrients were translocated during gestation, thus indicating matrotrophy in a species considered to be ovoviviparous. In particular, phospholipids and vitellogenin appear to be transferred from the maternal circulatory system to developing embryos. Groundfish Physiological Ecology Investigation scientists have completed a laboratory experiment addressing phospholipid dynamics and are starting the analysis of vitellogenin transport and yolk protein characterization.

Pregnant females were injected intravenously with ^{14}C-phosphatidylcholine when embryos were in optic vesicle and pectoral fin developmental stages (approximately 8 and 15 days postfertilization, respectively). Embryos withdrawn by catheter as development progressed contained radiolabeled carbon. Data have not been refined to allow final evaluation yet; however, compared to somatic tissues assayed postmortem, embryos incorporated about three times more radioactivity than muscle on a weight-specific basis. As expected, liver tissue contained the greatest levels of specific activity, about two to four times the levels found in embryos. These data clearly show that embryos derive substances from maternally circulated phospholipids and are therefore matrotrophic with respect to lipids.

Typically, transport of vitellogenin, the precursor of yolk proteins, ceases prior to fertilization in those few live-bearing teleosts examined. Serum data from pregnant females suggest that this may not be the case for yellowtail rockfish. To validate previous data, we are determining the presence of vitellogenin in the serum of pregnant females by an independent method. Serum proteins are separated according to apparent molecular weight by polyacrylamide gel electrophoresis and are stained with cationic carbocyanine dye, to distinguish proteins containing phosphorus and/or calcium from others. Vitellogenin is characterized as the only phosphoprotein in female serum during breeding season and has a molecular weight in excess of 200K daltons.

The same methodology is being used to separate yolk proteins to determine their molecular weight distributions and the presence of phosphorus. The differential between distributions according to stage of embryonic development will indicate selective utilization and/or enrichment as embryogenesis progresses. The results of this analysis will extend the findings from the phospholipid uptake study to encompass a source of protein as well as lipids to intraovarian embryonic development. Recent energy budget calculations by nutritional component (lipid, carbohydrate, protein) suggested supplementation of both lipid and protein to embryos during gestation. (R. MacFarlane, [415] 435-3140)

INFORMATION TECHNOLOGY SERVICES

IT-95 Source Selection Process and Advisory Board Meeting

Dorothy Roll, manager of the Information Technology Services, attended the first meeting of the IT-95 Source Selection Advisory Board (SSAB) which was held March 23-24, 1992, at the NMFS Headquarters Office in Silver Spring, Maryland. The IT-95 SSAB of which Roll is a voting member, operates as an award recommendation panel to do a technical evaluation of the proposals for the National Marine Fisheries Service (NMFS) distributed processing computer system and to advise the Contracting Officer of their findings. The Board is chaired by the senior manager of the NMFS F/RE2-Data Management Division, who has the ultimate responsibility for the contract requirement. The voting members of the Board are the Chairperson, the Regional Data Base Administrators, and a representative from two other agencies. The non-voting members are the officers from the DOC and NOAA Contracts Office. Assisting the Board in their deliberations are the Technical Advisory Committee (TAC) consisting of the Benchmark Team with representatives from each NOAA Fisheries Region and the Business Advisory Committee (BAC) with representatives from NMFS, NOAA Contracts Office, and the Office of Management and Budget.

Other voting members attending the advisory board meeting were Michael Fraser, Chairperson (NMFS Headquarters), Eugene Heyerdahl (Northeast Fisheries Science Center), Ted Rodgers (Alaska Fisheries Science Center), MaryAnne Treadway (Southeast Fisheries Science Center), Bob Chapman (National Institute of Standards and Technology), and Darrell Tidwell (NOAA Aircraft Operations Center). The non-members were the contract specialists Ina Merson (NOAA), Rusty Beeg (NOAA), and Attorney Mark Langstein (Department of Commerce). Representing the TAC were Jim Sargent, Ray Glass, and John Chaklis (NMFS Headquarters). Serving a dual role were BAC members Eugene Heyerdahl and Rusty Beeg.

The purpose of this meeting was for the SSAB to become familiar with the technical proposals, to review the preliminary recommendations from the TAC, to receive guidance on various technical and policy issues, and to check the status of the cost analysis by the BAC. The cost proposals will be evaluated by the BAC for completeness, magnitude, and realism; will receive a non-numerical rating; and will be ranked in descending order by cost. The technical factors will be weighted more than cost factors, with approximately a 65/35 split.

The meeting focused on the technical evaluations of the IT-95 proposals, presented by Jim Sargent, TAC Chairperson. The SSAB reviewed and discussed in detail the mandatory and desirable scoresheets for all vendors in tandem with the draft notes discussing the relative strengths and weaknesses of each proposal.

After the TAC receives the vendors' responses to questions which were sent out at the end of February, they will convene to re-evaluate the technical proposals based on the SSAB's recommendations. On the basis of these technical scores and the vendors' cost proposals, the Contracting Officer will determine the initial competitive range. Those vendors within this range will be scheduled for site visits for benchmark tests. After the TAC rescores the technical factors based on the benchmark test results, the Contracting Officer will determine the final competitive range. The selected vendors will be advised of their deficiencies and be asked to submit a Best and Final Offer.

Upon evaluation of the Best and Final Offers, the SSAB, with advice from the Contracting Officer, will prepare the final draft summarizing recommendations for review by Dr. William Fox, NOAA Assistant Administrator for Fisheries. His recommendations will be forwarded to Under Secretary and NOAA Administrator Dr. John Knauss, the Source Selection Official who will make the final decision and pass these along to the Contracting Officer for implementation. (D. Roll, [619] 546-7057)

PUBLICATIONS

Published

Bushnell, P. G., and R. W. Brill. 1992. Oxygen transport and cardiovascular responses in skipjack tuna, *Katsuwonus pelamis*, and yellowfin tuna, *Thunnus albacares*, exposed to acute hypoxia. J. Comp. Physiol. B 162:131-143.

Responses to acute hypoxia were measured in skipjack tuna, *Katsuwonus pelamis*, and yellowfin tuna, *Thunnus albacares*, (1-3 kg body weight). Fish were prevented from making swimming movements by a spinal injection of lidocaine and were placed in front of a seawater delivery pipe to provide ram ventilation of the gills. Fish could set their own ventilation volumes by adjusting mouth gape. Heart rate, dorsal and ventral aortic blood pressures, and cardiac output were continuously monitored during normoxia (inhalant water [PO_2 150 mmHg]) and three levels of hypoxia (inhalant water [PO_2 130, 90, and 50 mmHg]). Water and blood samples were taken for oxygen measurements in fluids afferent and efferent to the gills. From these data, various measures of the effectiveness of oxygen transfer and branchial and systemic vascular resistance were calculated. Despite high ventilation volumes (4-71 min^{-1} kg^{-1}), tunas extract approximately 50 percent of the oxygen from the inhalant water, in part because high cardiac outputs (115-132 ml min^{-1} kg^{-1}) result in ventilation perfusion conductance ratios (0.75-1.1) close to the theoretically ideal value of 1.0. Therefore, tunas have oxygen transfer factors (ml O_2 min^{-1} $mmHg^{-1}$ kg^{-1}) that are 10-50 times greater than those of other fishes. The efficiency of oxygen transfer from water in tunas (65 percent) matches that measured in teleosts with ventilation volumes an order of magnitude lower. The high oxygen transfer factors of tunas are made possible in part by a large gill surface area; however, this appears to carry a considerable osmoregulatory cost as the metabolic rate of gills may account for up 70 percent of the total metabolism in spinally blocked (i.e., non-swimming) fish. During hypoxia, skipjack and yellowfin tunas show a decrease in heart rate and increase in ventilation volume, as do other teleosts. However, in tunas, hypoxic bradycardia is not accom-

panied by equivalent increases in stroke volume, and cardiac output falls as heart rate decreases. In both tuna species, oxygen consumption eventually must be maintained by drawing on substantial venous oxygen reserves. This occurs at a higher inhalant water PO_2 (between 130 and 90 mmHg) in skipjack tuna than in yellowfin tuna (between 90 and 50 mmHg). The need to draw on venous oxygen reserves would make it difficult to meet the oxygen demand of increasing swimming speed, which is a common response to hypoxia in both species. Because yellowfin tuna can maintain oxygen consumption at a seawater oxygen tension of 90 mmHg without drawing on venous oxygen reserves, they could probably survive for extended periods at this level of hypoxia.

Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogeographic approach. Conserv. Biol. 6(1):24-36.

The "stock" is the fundamental population unit of legally mandated conservation efforts, yet its formal definition in the scientific literature and in two U.S. conservation acts is varied and so general that attempts to apply it in practice are arbitrary. Because choice of stocks deserving management protection is sometimes politically contentious, improvement of the working definition is important.

A key element should be the degree to which a population can be considered an evolutionarily significant unit. We propose that a hierarchial classification scheme be applied to stock designations. Category I populations, having the highest probability of being evolutionarily significant units, are characterized by a discontinuous genetic divergence pattern where locally adapted and closely related genome assemblages are separated from others geographically and by significant genetic distances. Category II populations are similarly characterized by significant genetic diversity, but with weak geographic partitioning. Category III populations are the converse of II, having little genetic differentiation between assemblages that are clearly separate and likely to be reproductively isolated. Category IV assemblages have the lowest probability of being evolutionarily significant units and are characterized by extensive gene flow and no subdivision by extrinsic barriers. In addition to phylogeographic designation, the following information is used in the classification, as indicated by single-letter abbreviations: distribution (a), population response (b), phenotypic (c), and genotypic (d) information. Included are evidence both for and against designating population as a separate stock in the designation "Type II a/bc"; for example, information to the right of the solidus would be evidence for "lumping," to the left would be for "splitting." Missing letter abbreviations would signify lack of reliable data. Note that phylogeographic designation depends on the results of selection operating to produce a locally adapted genome (indicated by differences in demographic, phenotypic, and genotypic measures) and on gene flow (indicated by differences in distribution or by movement data).

Hierarchial stock categorization allows resource managers to direct limited resources to the populations most deserving of protection, that is, the populations that are most likely to be evolutionarily significant units. Using this comprehensive classification of stock allows preliminary, conservative splitting of assemblages where data are lacking without the danger that these divisions will become entrenched as biological dogma.

Fiedler, P. C., F. P. Chavez, D. W. Behringer, and S. B. Reilly. 1992. Physical and biological effects of Los Niños in the eastern tropical Pacific, 1986-1989. Deep-Sea Res. 39:199-219.

The eastern tropical Pacific Ocean was surveyed in August-November 1986, 1987, 1988, and 1989 as part of a long-term program to monitor dolphin stocks. Temperature, salinity, chlorophyll, and nutrients were monitored to help interpret variability in dolphin stock estimates. The four surveys reveal major environmental changes during the moderate 1987 El Niño and the cold La Niña episode that followed in 1988. During the "onset" phase of El Niño in the fall of 1986, surface temperatures were up to 1.5°C above normal in equatorial water, but near normal in tropical water north of the equator. The equatorial thermocline ridge was deepened by 10-30 m. During the "mature" phase of El Niño in fall 1987, surface temperatures anomalies were up to +2.5°C in equatorial water and about +1°C in tropical water. Thermocline topography was anomalously flat. Surface chlorophyll and nutrient concentrations declined by 11-48 percent compared to 1986, with the greatest declines occurring in coastal and equatorial upwelling systems and along the countercurrent thermocline ridge. During La Niña 1988, equatorial surface temperatures were up to 2.5°C below normal and the equatorial thermocline ridge was 10-50 m more shallow than normal. Chlorophyll and nitrate concentrations increased by 58-65 percent compared to 1987. In 1989, surface temperature was within 1°C of normal throughout the study area and chlorophyll concentrations were similar to those observed in 1986. Changes in nutrient availability and biological productivity during the El Niño/La Niña cycle were caused by variations in both the rate of wind-driven upwelling and in the nutrient content of subsurface water entrained by upwelling.

Hobson, E. S. 1991. Hazardous aquatic organisms. Section 12, NOAA Diving Manual, p. 12-1 to 12-12. U.S. Dep. Comm., NOAA, U. S. Government Printing Office, Washington, D. C.

Many aquatic animals are potentially hazardous to divers; this chapter of the NOAA Diving Manual describes those one might encounter in the course of the many underwater activities performed by agency personnel. Ways to minimize or avoid these hazards are suggested.

Smith, M. K. 1992. Regional differences in otolith morphology of the deep slope red snapper, *Etelis carbunculus*. Can. J. Fish. Aquat. Sci. 49:795-804.

Sagittal otoliths from four populations of the Pacific deep slope red snapper, *Etelis carbunculus* (Cuvier), were compared using Fourier descriptors and other shape indices, linear proportions, and dry weight. Otoliths from Hawaii, Vanuatu, Fiji and French Polynesia and a small number from the commonwealth of the Northern Marianas Islands (NMI) were examined. Regional shape and weight characteristics were distinguishable despite the wide range of individual variation and limited available size range from some regions. Size-specific differences in otolith shape were found for the four regions for which a sufficient sample was available. Otoliths from Hawaii, French Polynesia and NMI showed a significant shape affinity. Otoliths from Fiji and Vanuatu were similarly shaped and were distinct from those from the other three regions. Interregional otolith shape affinities for the stocks examined parallel similarities in maximum size and growth rate from the literature, suggesting that growth rate may influence otolith shape. Observed trends in otolith weight as a function of fish length support growth-related regional differences in otolith shape.

Smith, P. C., and F. B. Schwing. 1991. Mean circulation and variability on the eastern Canadian continental shelf. Cont. Shelf Res. 11:977-1012.

The circulation and variability on eastern Canadian continental shelves is reviewed with emphasis on horizontal and vertical structure in the water column. Mean and seasonal currents, sheared by stratification and friction, generally follow bathymetry and are driven primarily by surface wind stress and buoyancy fluxes. In certain near-resonant embayments, nonlinear interactions of the tide also make significant contributions to the mean and low-frequency currents. Direct forcing of low-frequency shelf circulation by offshore currents and pressure fields is of lesser importance according to recent observations and models. At higher frequencies, the wintertime response to atmospheric forcing occurs in three important frequency bands: surface wave (periods of 2-20 s), inertial (17-22 h) and synoptic or subtidal (2-10 days). Most of the subtidal energy in the subsurface pressure (SSP) field is attributable to direct local forcing by alongshore wind and to remote forcing by coastal-trapped waves (CTW). The subtidal current variability is less coherent with these sources primarily because of small-scale circulations created by vortex stretching, topographic steering, and scattering by the rugged shelf bathymetry. Bottom friction and scattering control the ratio of locally and remotely forced subtidal energy as a function of position on the shelf. Intermittent inertial currents in stratified shelf waters, often associated with mesoscale atmospheric forcing, exhibit a 180° phase change across the pycnocline and are inhibited near the coast. Surface waves generated by storm winds are strongly dissipated in shallow water where they enhance bottom stresses that (1) balance the surface wind stress and (2) may contribute to the damping of inertial waves. Specific examples of these phenomena are drawn from observations on the Scotian Shelf and in the Gulf of Maine.

Thomson, C. J. 1991. Effects of the avidity bias on survey estimates of fishing effort and economic value. Am. Fish. Soc. Symposium 12:356-366.

This paper describes the avidity bias (the disproportionate representation of avid anglers) in intercept surveys and shows how bias-corrected estimates of mean and variance can be computed. It compares bias-corrected participation rates with actual participation rates reported by California anglers in an economic survey conducted as a mail follow-up to a random telephone canvass and in an on-site intercept survey. Although both samples contained this bias, it was much more pronounced in the on-site survey than in the mail survey. The findings indicate that failure to correct for avidity bias results in inflated estimates of per capita fishing expenditures and consumer surplus as well as fishing effort. In general, the effect of the avidity bias on estimates of economic value depends not only on the extent of the bias, but also on the relationship between angler expenditures and avidity, and on the functional form of the travel cost model underlying estimates of consumer surplus.

Approved by Science and Research Director, SWR

Adams, P. B., S. Ralston, and T. E. Laidig. Distribution, patchiness, growth, and hatch date of pelagic juvenile lingcod, *Ophiodon elongatus*, off central California. For consideration for publication in *Canadian Journal of Fisheries and Aquatic Sciences*.

Balazs, G. H. Innovative techniques to facilitate field studies of the green turtle, *Chelonia mydas*. For consideration for publication in Proceedings of the 1992 Sea Turtle Symposium.

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Administrative Reports are strictly for internal use only and are not to be cited or treated as publications.

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Abstracts

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Brill, R. W. 1992. Horizontal and vertical movements of striped marlin, *Tetrapturus audax*, in Hawaiian waters determined using ultrasonic telemetry, with simultaneous measurement of oceanic currents. 43rd Tuna Conference, University of California Conference Center, Lake Arrowhead, CA, May 18-21, 1992.

Erratum: The following figure is a correction to Figure 1, printed on page 19 in the January/February issue of the Bimonthly Report under the subheading "Physical Condition of Spawning Female Blue Rockfish Improved During 1992." The correction relates to the diets of blue rockfish. The upper percent in 1990 and 1991 should have shown "other" rather than "juvenile *Sebastes spp.*"

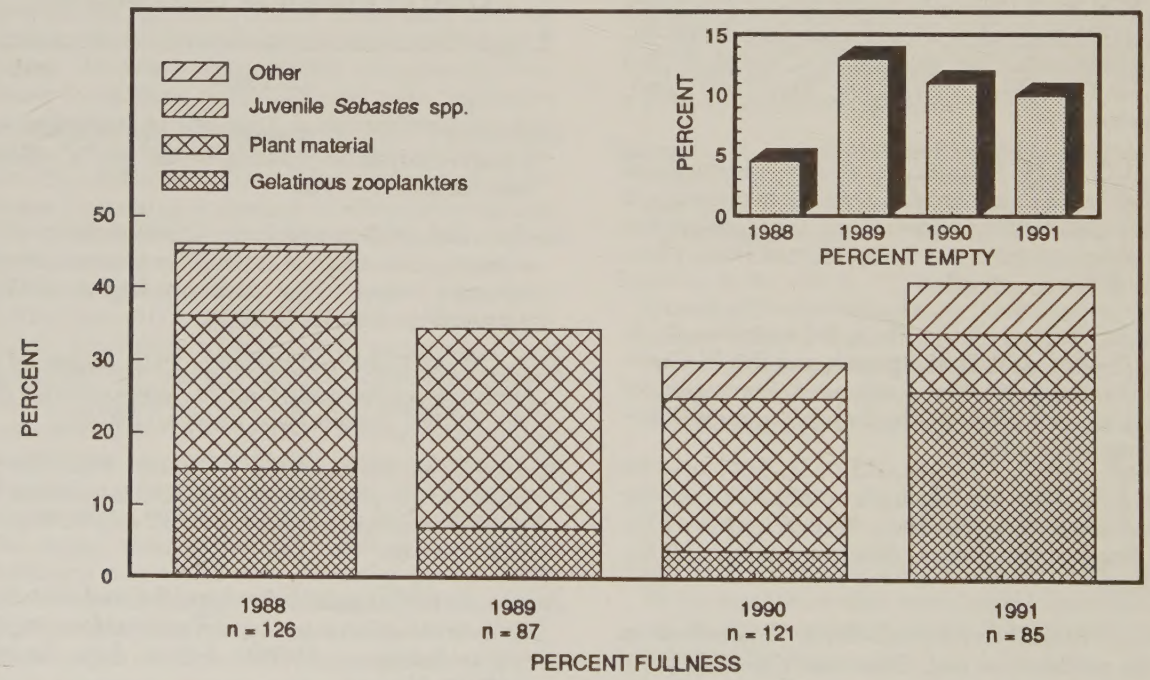

Figure 1. Feeding by adult female *Sebastes mystinus* from June to November, 1988-1991.

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